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Railways, Electric Railways, Elevated and Cable Railways, Horse and Motor Railways, Highways, Bridges, Tunnels and Canals, Water-Works, Irrigation, Sewers, Streets, Electrical, Contract Prices, Miscellaneous, Manufacturing and Technical, Current Price List.

Fires in 1891 destroyed property in the United States exceeding $125,000,000 in value. This is nearly 50% more than last year, though there were no grand conflagrations. It is estimated that premiums, expenses of offices, maintenance of fire departments, etc., about double the actual fire losses. Hence the people of the United States paid this year about $250,000,000 for ashes, a sum that would go far toward rendering our buildings more nearly fireproof.

The first 12-in. gun made at the Washington gun shops of the Navy was tested at the Indian Head proving grounds on Tuesday, Dec. 22. Five shots were fired, and the best result obtained was an initial velocity, of 1,941 ft. per second for an 850-lb. projectile, using a charge of 430 lbs. of brown powder from the Dupont works. The chamber pressure recorded was 13⅞ tons. This is stated to be fully equal to the best yet attained either here or abroad. It is stated that the best result which the U. S. Army has obtained with a 12-in. gun using brown powder is an initial velocity of 1,181 ft. per second for a 1,000-lb. projectile, using a charge of 440 lbs. of powder, producing a chamber pressure of 17 tons.

The new Canadian Sault Ste. Marie Canal lock has been increased in size, on the plans, from 600 ft. by 85 ft. to 900 ft. by 60 ft. The gates are to be of the full width of the canal in the new plans. A twin lock is also provided for in case it is demanded by commerce. The new lock is to be opened in time for the season of 1892.

The Trenton bridge, across the Delaware River, is being widened by the Pennsylvania Railway Co. The extended piers have been ready for some time.

An Alaska railway is the subject of a bill presented to the United States Senate by Senator Stewart. The bill grants permission to the Alaska Mining & Development Co. to build a railway from Portage Bay to Herendeen Bay on the Bering Sea, with grants of government land for right of way and terminals. The mining and shipping of coal seems to be the main object of the enterprise.

A bowlder, 190 ft. high and weighing about 2,000 tons, is said to have been recently rolled out of the way of the builders of the Mexican Southern Railway. The rock was dislodged by dynamite and thrown over.

The proposed bridges across the North and East Rivers at New York, have been made the subject of a communication addressed to the U. S Senate by Mr. A. H. Green, President of the Municipal Consolidated Inquiry Commission. The commission fears that Senate Bill 846, which is intended to authorize and regulate the construction of bridges across these rivers, and so prescribe their dimensions, does not make due allowance for the differences of the two rivers in width and topography of shores. It is thought that the bill as framed would prevent the construction of any new bridge over these rivers and thus obstruct the movement of commerce. This bill is supposed to be due to the opposition of the New York & New Haven Railway and the Union Ferry Co. to the erection of bridges across the North and East Rivers.

A 50-ton nickel-steel ingot was successfully cast at the works of Carnegie, Phipps & Co., recently. The ingot was 60 ins. wide by 180 ins. long and 40 ins. thick.

Two girders, each 102 ft. 6 ins. long and 6 ft. deep, were erected over the Mattabassett River, at East Berlin, Conn., on Dec. 20. They were built and erected by the Berlin Bridge Co., of the same place.

Rapid transit in Boston would absolutely require the widening of several important streets in that city, and the necessity for this action is likely to prove a stumbling block to the immediate work of the present rapid transit commission. New powers must be sought from the Massachusetts legislature, giving the Commission the right to condem and acquire all property effected by the widening of a street, instead of only the 10 ft. or more actually needed. Under the new act the city would usually be enabled to sell the untouched portion of individual property at a profit, instead of paying exorbitant prices for the smaller section occupied by the new street.

The worst accident in every sense for many weeks was a tail collision on Christmas eve on the New York Central & Hudson River R. R., just above Hastings. It is the last of a long series of such collisions on this road, due primarily to the absence of any system of block signals for handling its crowded traffic, and secondarily to the negligence of employees at critical moments.

The engine of a "Croton local," which left New York at 6:40 p. m., had broken down at Dobbs Ferry. The Niagara Falls express, leaving New York at 7:30, had in consequence been stopped about ¾ mile below Dobbs Ferry, and an equal distance above Hastings. The train consisted of a combination baggage and smoker, day coach and two Wagner sleepers, the rear one of which, the "Gibraltar," contained 22 passengers, of whom 12 were shortly to die and 8 be more or less injured by the collision which was to follow, leaving only 2 uninjured.

Brakeman Albert E. Herrick was sent back to Hastings to protect the train's rear. The next regular train was another Croton local, leaving New York at 7:35 p. m., due to stop at Hastings at 8:12. Following it (on the schedule) was the St. Louis express, leaving New York at 8 p. m., and due to pass Hastings about 8:30 p. m. The Croton local had been held back at Yonkers, but not knowing this, and counting on its preceding the express and stoping at Hastings, Herrick went into the station to take a smoke or a Christmas nip with the station agent, and realized his fatal error only as the express thundered by, since which event he has disappeared. The locomotive of the express completely telescoped the "Gibraltar," most of the casualties being caused by the great volumes of steam from its ruptured boiler connections, and by fire started from its fire box.

The officers of the road express great regret for the occurrence, and announce their readiness to block signal the road, at least as far as to Albany, whenever it is shown to their satisfaction which is really the best of all the block signal systems in existence.

An innovation in Bessemer steel manufacture has been successfully introduced at the new works of the Maryland Steel Company at Sparrow's Point, near Baltimore, and is soon to be adopted in the Edgar Thomson works of Carnegie Bros. at Braddock, Pa. By the ordinary method of working, the converter empties its contents after blowing into a ladle carried by a hydraulic jib crane, with its mast at the center of a shallow pit, around the circumference of which the molds for the ingots are ranged. In the new method of working, the pit is done away with and the ingots are moved on cars up to the ladle crane. Here they are filled and then moved forward to be stripped. The saving in labor and time in handling of the ingots and molds is evident enough. The "Iron Age" states that at Sparrow's Point the new system has worked successfully, even when by accident the flow from the ladle was extraordinarily rapid, and also in an emergency when it was necessary to pour the steel over the top of the ladle instead of tapping it.

The use of soaking pits without fuel, according to the same authority, has been tried at Sparrow's Point, but has not yet worked successfully; and a set of gas-fired soaking pits is being put in. The rolling mill at this place has proved the rolling of six-length rails on a three-high train to be perfectly practicable. The most remarkable innovation in rolling mill practice, however, is that which has been recently introduced at the Edgar Thomson works of rolling several pieces simultaneously on the intermediate train of rolls. For example: A bloom coming from the roughing rolls passes between the lower rolls and is then raised by the table to be returned between the upper rolls. At the same time a second bloom comes forward to the intermediate train and is passed through between the lower rolls. It is even stated that three pieces have been rolled simultaneously in this three-high train. The motive power for these rolls is furnished by a Porter Allen horizontal engine, with 54 × 66 in. cylinder, running at 100 revs. per minute.

An electric tricycle of a new design has been brought out in Paris by Mr. H. de Graffigny, and is described in "Le Génie Civil." It is an ordinary tricycle in which the saddle is replaced by a box-seat of light wood. The motor is a battery of 18 elements which with its liquid weighs about 44 lbs. The small dynamo moves the pair of large wheels by double gearing and a link belt, and the whole vehicle complete weighs about 154 lbs. In a test covering two months the machine was found to develop about one-third of a horse-power for four hours. With two people on it it develops a speed of 11 to 12 miles per hour on a good level road. The present cost of renewing the batteries is about 50 cts. per electric horse-power; but the inventor believes this can be much reduced.

The plans for the Cornell dam of the new Croton Aqueduct have been approved by the Aqueduct Commission. The plans for the property needed were approved on Nov. 30 last.

In 77 German cities, aggregating a population of 7,600,000, 26% of these cities sell water exclusively by meters, says the London "Architect." In the remaining cities the meter has been generally adopted. Since 1878 Berlin has used the meter exclusively in selling water.

The high-pressure water mains laid in London on the Ellington system by the London Hydraulic Power Co., now cover 53 miles in length, chiefly in the city, and among other motors operate 1,470 hydraulic lifts. The system was first put down about 6 years ago, and in 1887 was 25 miles long. The pressure at the street surface is the equivalent of a head of 1,709 ft., obtained from three pumping stations with an accumulator pressure of 750 lbs. per sq. in. Mr. Ellington reports much trouble in laying the mains, due to obstructing pipes, conduits, etc., already under the streets.

A steam tramway and fresh water canal are to be built along the Suez Canal, from Ismailia to Port Said, or along about one-half of the canal. The railway is to be used exclusively for mails, passengers and the company's service, and it is expected that it will be finished by the end of next year.

The Rapid Transit Commission of New York is now considering the hostile attitude of property holders along Broadway, and by legal advice is asking that another commission be appointed to consider these refusals and to enquire into the advisability of constructing the road and to report to the General Term. If the Court decides that the interest of the public will be served by building the road, this decision may be taken in place of the consent of property owners.

An electric mining locomotive, made by the Edison General Electric Co., has been lately tested by the Loyal Hanna Coal Co., of Pennsylvania. The contract called for a locomotive that would deliver 360 tons of coal per hour at the shaft. To do this it had to haul 30 cars, weighing 1 ton each and carrying 3 tons of coal, a distance of 4,000 ft. every 15 min. There are sharp curves and grades of 4 to 5% to be overcome. Though the figured speed was 7½ miles per hour, at the test 12 miles were made. The capacity of the locomotive was found to be far in excess of these requirements, and the heavy trains were handled with ease and facility.

The St. Mary Ship Canal, according to the annual report of Gen. O. M. Poe, had a season of 225 days in 1891. The average passages per day were 45.3, and the average registered tonnage was 862.1 tons, or a total of 53,750 less than last year. The amount of freight passing through was 152,454 tons less than in 1890. Iron ore formed 50% of all the freight. The value of the entire freight passing increased 25% over the preceding year, owing to the large wheat crop. The average depth of water was 14.42 ft., lower than in any previous year. With the same depth of water as in 1890 the 9,744 vessels passing would have carried 1,161,359 tons more than they did.

THE STEEL SKELETON TYPE OF HIGH BUILDINGS.

IV.

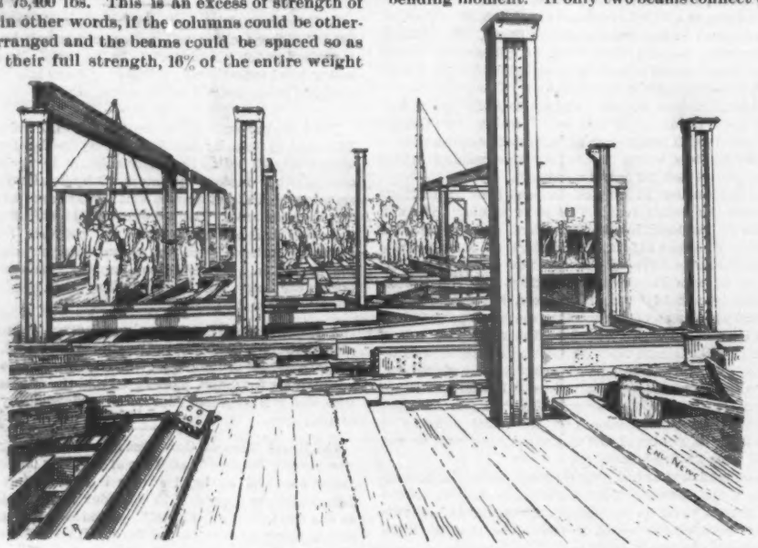
By C. T. Purdy.

[Concluded from page 608, Vol. XXVI.]

BEAMS AND SPANDREL CONSTRUCTION.

There is opportunity for a good deal of study regarding the economical arrangement of floor beams. No principles have been laid down, so far as the writer knows, bearing on the subject, and there is no uniformity of practice. A few general suggestions, however, may be made.

If the designer can fix the positions of the columns in a building so that the beams and girders shall be strained up to the allowable fiber strain, there will be more economy than if the arrangement of the columns is such that in order to obtain a beam heavy enough to carry the required load he must use a beam that will carry a load 10% or 15% heavier. This is a simple way of putting it, but a good many thousand dollars are put into buildings unnecessarily because this point is not heeded. The true way is to first fix upon the loads that the beams must carry per square foot of floor area, and then fix the spans of the beams and the distances between them so that this required load will strain the beams fully to the allowed fiber strain. A very small difference in the position of columns may make this a possible thing or an impossible one. Suppose the arrangement is such, for example, that the required load causes a bending moment of 65,000 ft.-lbs. in the joist beams. The arrangement of the columns that necessitated such a condition would be bad. The lightest beam that will carry such a load with an allowed ultimate fiber strain of 16,000 lbs. is a 15-in., 41-lb. steel beam, whose moment of resistance is 75,400 lbs. This is an excess of strength of 16%; or in other words, if the columns could be otherwise arranged and the beams could be spaced so as to use their full strength, 16% of the entire weight of the floor beams thus used would be actually saved; and in even a small building this would amount to enough to pay for all the work of designing the iron construction and more. This is so plain that it seems hardly worth mentioning, and yet many cases have come to the writer's notice like the example given.



THE FOURTEENTH FLOOR OF THE ASHLAND BLOCK.

If large orders are being made, beams may be ordered to weight the same as angles, but there is generally not much to gain by doing this. With the ultimate fiber strain of 16,000 lbs per sq. in. the moment of resistance of a 15-in. 50-lb. beam is 94,200 ft.-lbs. The moment of resistance of a 15-in. beam weighing 55 lbs. rolled by the same rolls is 103,200 ft.-lbs., while the moment of resistance of a 15 in. 60-lb. beam is 118,000 ft.-lbs.

It will be seen by this that it would be better economy to space beams so as to require either the 15-in. 50-lb. beam, or the 15-in. 60-lb. one. Again, it is rarely economy to use the heavier weights in beams when it can be avoided.

The moment of resistance of a 15-in. 75-lb. beam is 134,700 ft.-lbs., while the moment of resistance of a 20-in. 64-lb. beam is 152,800 ft.-lbs., a less weight and greater resistance. The same is true of smaller beams. A 12-in. 32-lb. beam is much stronger than a 10-in. 33-lb. beam. In designing girders it is profitable to arrange them so that two beams shall connect to a girder rather than one or three. If one or three beams connect to the girder, one joist load will be applied directly in the middle of the girder, where the load counts for most in making a large bending moment. If only two beams connect to the girder, the spacing will make the moment arm only one-third the length of the girder.

The Ashland Block, Chicago, During Construction.

There has been a tendency to long spans, both for girders and for beams. Most of the floor beams in the Woman's Temple are 30 ft. long and the girders are also very long, 15-in. beams being used throughout the building. Whether this construction is more or less economical than shorter spans and more columns is doubtful, and only a very careful analysis of loads and their effects on both beams and columns with all attending conditions, could demonstrate the truth of the matter.

Fig. 1 shows the usual arrangement of the material in the floors of an ordinary office building. The 3½ ins. between the top of the beams and the floor line is required for the water and gas pipes. The space between the arch and the wood or the tile flooring is filled with cinder concrete made as light as possible, and strips imbedded in this concrete afford a base on which to lay the wood flooring. Where the spans are so arranged that the girders can be made of the same size of beams that the joists are, it is necessary, of course, to notch the beams or cope them, as it is termed, where the joists frame into the girders. Sometimes the arrangement of the building is such that the girders may be allowed to project below the floor on partition lines, and occasionally it occurs that the design of the building is such that it is certain beforehand that the plumbing will not be interfered with if the girder beams project an inch or so above the floor beams. In such cases the beams may be framed into the girders without coping, and thus make it both a better piece of work and more economical. The almost universal practice in Chicago office buildings, however, is to design the floor construction so that the ceilings shall be a plain surface throughout the building. This permits of any arrangement of the room partitions and always insures an unbroken ceiling.

Carnegie, Phipps & Co.'s standard connections are used wherever possible in fitting beams into girders. They are usually ample in strength and the use of standards simplifies the work for both the engineer and the manufacturer. The connections of beams to columns have undergone some radical changes since the use of steel columns began. The first practice was to carry beams almost entirely on brackets. Nowthey are carried almost entirel yon the top plates, and great care is used to keep the end of the beam as close to the center of the column as possible. Practice varies in regard to clearances; ⅛ in. at the ends of beams connected to girders and ¼ in. at the end of beams connected to columns are used in many of our large buildings, and these figures seem to be a very fair compromise between the ideal thing and what is required for the convenient erection of the iron work. Tie rods are customarily spaced 6 ft. to 7 ft. apart, and cast separators should always be provided where double beams are used, not only to keep the beams at the proper distance from each other, but, what is of much greater importance, to equalize the load upon the two beams. All the beams are fireproofed, both above and below, while the tile arches protect the beams on the sides.

There has been a radical change in the construction of these arches during the last year. In the old method the hollow spaces in the arches ran parallel to the beams; in the new method they run at right angles, bringing all the weight of the arch into service and increasing its strength materially, while the total weight is considerably decreased. With a 12-in. arch of this new pattern, 6½ and 7 ft. spaces between beams are practicable and often desirable. The weight of these new arches is as follows:

9-in. arch	=	25 lbs.	per	sq.	ft.
10 " "	=	30 "	"	"	"
12 " "	=	35 "	"	"	"
15 " "	=	45 "	"	"	"

These are fully 25% lighter than the old ones, which makes a great reduction in the weight of the building. There has also been a great reduction in the weight of partitions. The old tile is being replaced in some buildings with Mackolite, reducing the weight fully 33% per sq. ft. of partition.

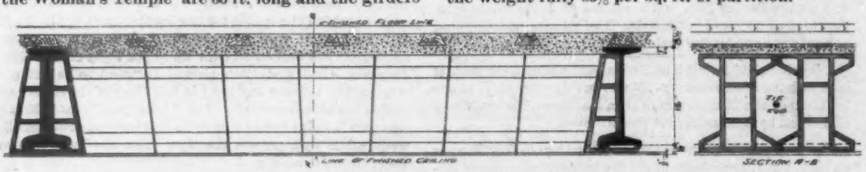


FIG. 1. USUAL ARRANGEMENT OF MATERIAL FOR FLOOR OF OFFICE BUILDING.

The present demand for great buildings has produced many novelties in steel construction. Some have real merit, but most of them are wanting in some essential, and it is extremely difficult to secure the introduction of any untried material or methods of construction in these great buildings. In spite of the fact that Chicago leads in steel construction and

new architectural methods, there is probably no other city in this country that is more conservative about using both materials and methods whose efficiency and worth have not been fully demonstrated.

The arrangement and use of spandrel beams varies greatly in different buildings and depends almost entirely upon the designs of the architect. If the exterior walls of the building are all flush, as they are in the Venetian Building, the arrangement of the iron must be entirely different from what is used when the curtain walls are in reveal, as they are in

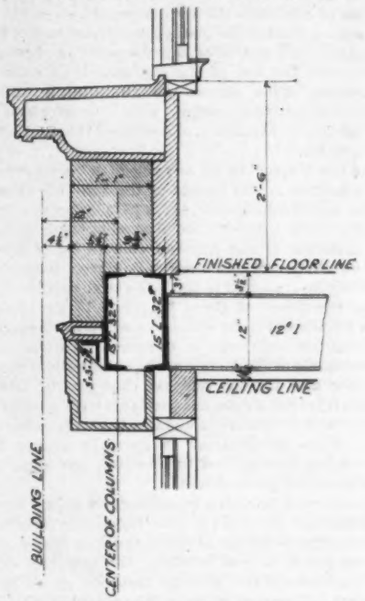


Fig. 2. Spandrel Section Between Bay Windows, Ashland Block.

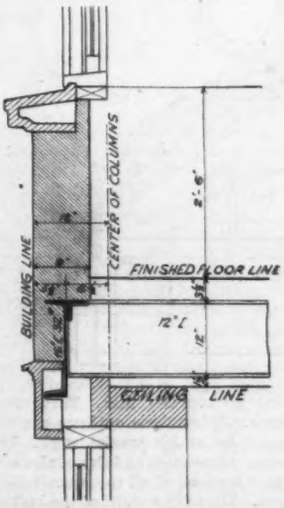


Fig. 3. Court Spandrel Section, Ashland Block.

the Fair Building. In most of these great buildings the exterior finish is made of pressed brick or terra cotta, the terra cotta being used for the window sills and window caps and often for horizontal bands extending entirely across the front of a building. If the curtain walls are flush with the building line, the arrangement of the iron in the spandrel should be made continuous the entire length of the wall. If the curtain walls are in reveal, some special arrangement must be made to carry the terra cotta or brick adjoining the columns where the construction projects to the building line.

If the building is not all steel construction, and piers take the place of steel columns in the front walls, this problem is very greatly simplified, as the beams can project into the piers and the curtain wall is the only thing to be supported. Occasionally the terra cotta is dispensed with and only brick is used, in which case the spandrel must be arranged so that the brick lintel can be suspended. Beams can also be arranged so that heavy granite or marble lintels may be relieved of the load of all the masonry that may appear to rest on them. Sometimes heavy granite soffits can be suspended from the ironwork; in fact, the combination of steel and stone, brick and terra cotta to carry loads safely and to obtain a given architectural finish are almost endless. To those who enjoy a puzzle the work of designing spandrels would prove to be full of unusual interest.

A number of drawings showing the arrangement of iron in spandrel sections are shown herewith. They have been chosen somewhat at random with the single idea of getting a variety of those ordinarily used. Figs. 2 and 4 show the spandrel in reveal, while in the other cases it is flush with the building line. In Fig. 2 one piece of terra cotta is

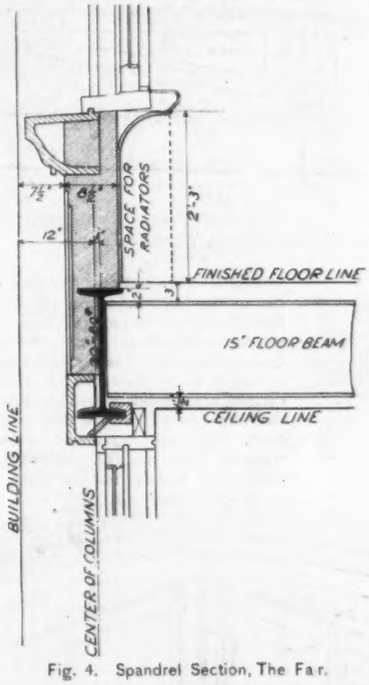


Fig. 4. Spandrel Section, The Fair.

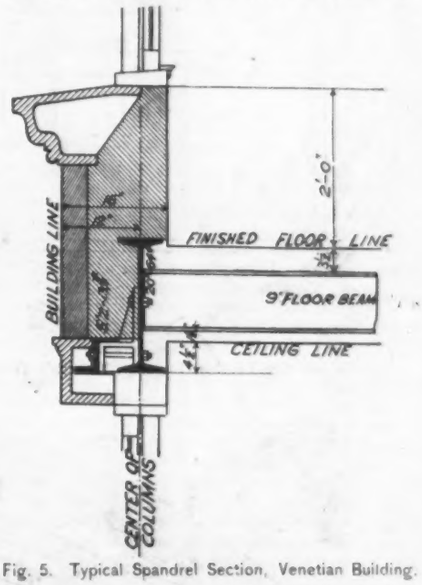


Fig. 5. Typical Spandrel Section, Venetian Building.

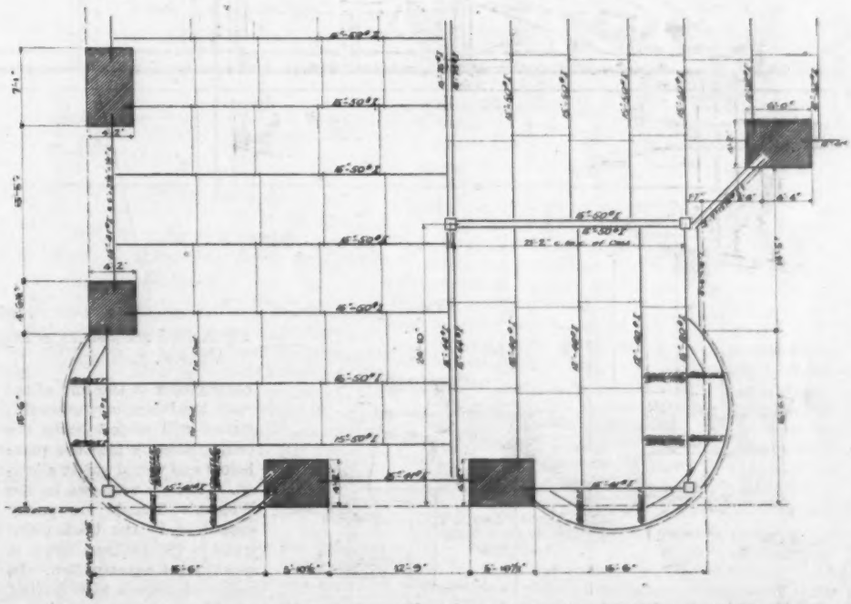


FIG. 6. PLAN OF FRAMING OF ONE WING OF WOMAN'S TEMPLE, CHICAGO.

suspended, while in all the others it rests directly on the iron. In the former case the angle is held out from the channel with separators at the rivets to permit the terra cotta anchors to come in behind the angle. These anchors are mostly ¼-in. square iron rods, hooked into the ribs of the terra cotta while hot and securely bent around the ironwork. Hook bolts are also much used in suspending terra cotta, in this case passing between the channels and bolting to a bar on top of them. In all cases a sufficient number of anchors are put in the terra cotta to securely fasten it in its proper place against the ironwork. Where the top of the terra cotta comes opposite the middle of a beam or channel, as shown in Fig. 3, holes are punched in the web through which the anchors pass and hook into the top of the terra cotta. The Z-bar, shown in section, Fig. 5, is supported entirely from the 20-in. beam by special cast iron separators and the long bolt passing through the three pieces. This arrangement makes an excellent bed for the brick, and brings all the eccentricity of the load on the beam instead of the column, to the great advantage of the latter. No two buildings are alike in their spandrel construction. Often a very small change in the exterior appearance will require a radical change in the arrangement of the iron carrying the load.

Chicago buildings are quite noted for their bay windows—the great number of them and the almost infinite variety. The possibility of building them safely and the demand for them have come with the growth of steel construction. The general scheme for their support is simple enough, though the details are sometimes complicated. All bay win-

dow walls, in the first place, should be designed as light as possible, then the spandrel iron that carries them should be supported by brackets and so designed that there will be no opportunity for them to yield under the load, either by twisting the beams behind them or by their own deflection. The support of the brick or terra cotta around them should be patterned largely after the other spandrel work in the building, and the bracket, if possible, should connect with the ends of floor beams at top and bottom so as to be continuous with the beam itself, and where this is not possible a counter bracket or brace should be provided, or else the spandrel beam is almost certain to twist. Fig. 6, a partial plan of the framing in the Woman's Temple, shows the arrangement of bay window brackets as they relate to the floor beams. Part of them come at the end of floor beams and part are counter braced, and in no case can the load twist the beam. Note also in this connection the larger details of these windows shown in Fig. 7. Fig. 8 shows the plan of one of the bay windows in the Ashland Block and the general character of the construction. It must be remembered that this arrangement occurs at every floor and the loads carried are almost invariably those that occur only from one floor to the next. In rare instances a bay window load can be carried by cantilever beams resting over a cross girder in the line of the wall; but in ordinary cases this girder will project below the ceiling directly into the room below and would not be allowed. The bay windows in the Woman's Temple are partly supported by the brick piers, while in the Ashland Block it is all steel construction. In both cases there is a tile furring the brick face, with a dead space between, bringing the windows into deep reveal. In one case the iron is arranged to carry a tile arch for both ceiling and floor, and in the other only a floor is required, for which T irons carrying book tile are provided,

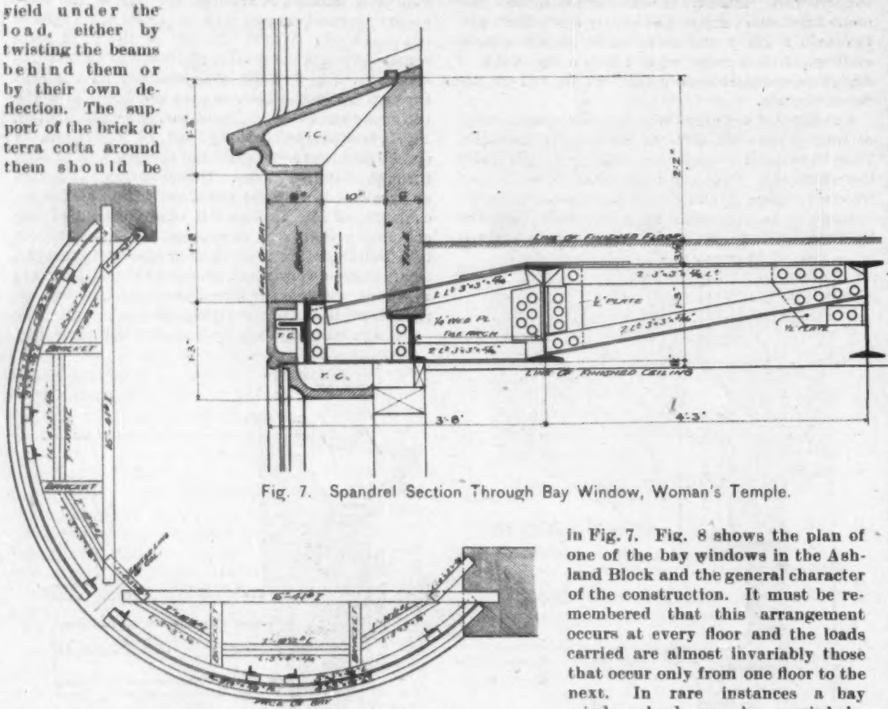


Fig. 7. Spandrel Section Through Bay Window, Woman's Temple.

Fig. 7. Bay Window Framing, Woman's Temple.

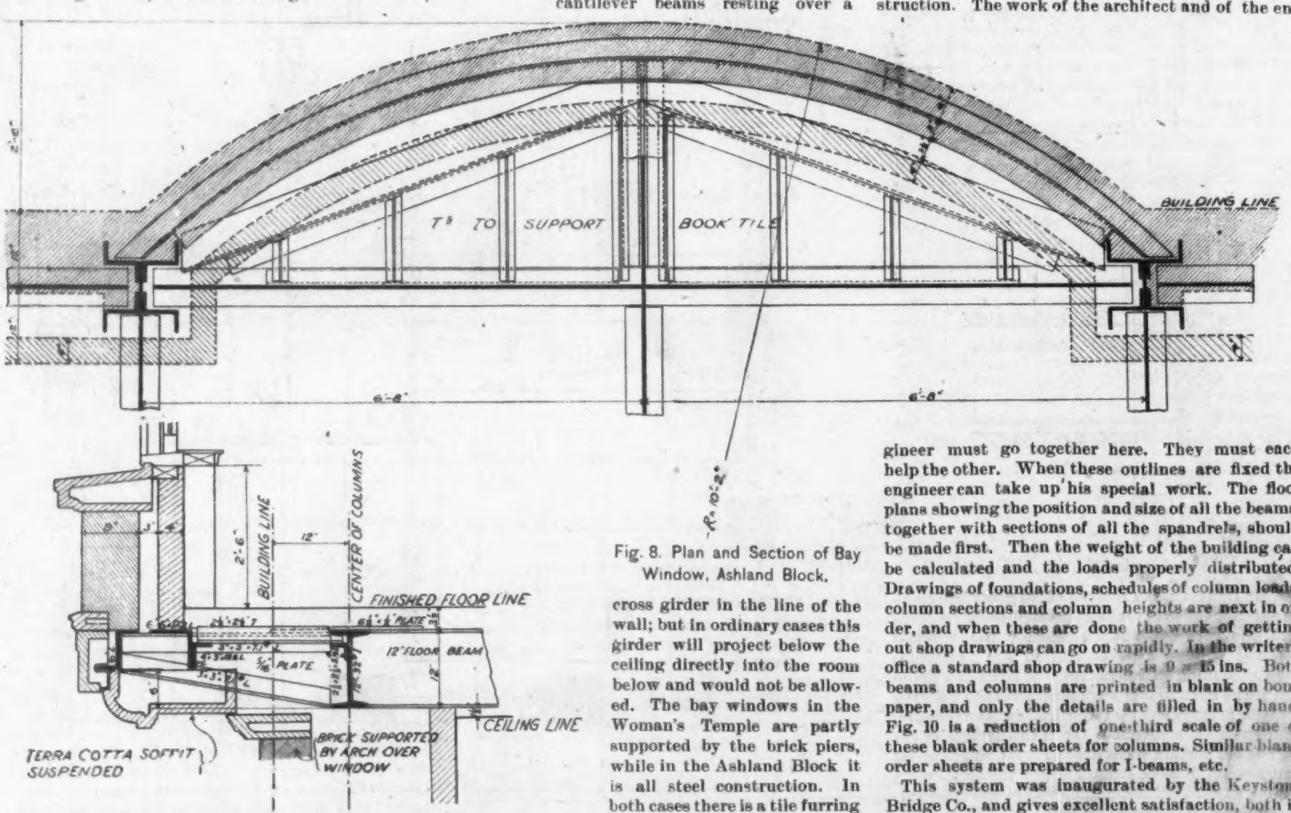


Fig. 8. Plan and Section of Bay Window, Ashland Block.

On the street fronts the columns make place for piers, or what seem to be piers, and the space between may be all glass, as on the front of the Venetian Building (see "Eng. News," Dec. 5, 1891), or divided into two or more windows with mullions between, as shown on the side of the same building. These mullions are always stiffened with iron connecting to the beams both above and below. Sometimes they are made of cast iron, ornamented and exposed above the window sill to the window cap, but usually they are entirely covered either with terra cotta or brick.

For that matter every inch of iron or steel in the building should be covered. The thoroughness with which columns can be inclosed is shown by the section of columns with fireproofing shown in Fig. 9. The square finish is the one generally used with Z bar columns. The weight of this fireproofing of course varies with the size of the column. On a column measuring 18 ins square on the outside, after plastering, the fireproofing would weigh about 62 lbs. per lin. ft. of column, or including the plastering about 90 lbs.

The tile is made to fit any size of column, square or rectangular. The weight of the solid tile shown on the round columns for, say, a 10-in. column, would be about 48 lbs., or with the plastering about 70 lbs., the diameter of the finished column being 15 ins. The two halves of the fireproofing are joined with metalclamps inserted in the holes as shown.

The resistance of these buildings to fires, both from within and from without, and their enduring qualities are constantly in question. We that are designing them think they are the best buildings for the place and for the purpose that can be built, though it is true we cannot back this with records of long years of service or of resistance to great conflagrations. Fires have started in them in several instances, but have gained no headway and done no damage to the construction.

A word must be added regarding the actual work of designing. First must come the general scheme, the arrangement of the columns and floor beams, the exterior finish of the building, the material that shall be used and the general methods of its construction. The work of the architect and of the engineer must go together here. They must each help the other. When these outlines are fixed the engineer can take up his special work. The floor plans showing the position and size of all the beams, together with sections of all the spandrels, should be made first. Then the weight of the building can be calculated and the loads properly distributed. Drawings of foundations, schedules of column loads, column sections and column heights are next in order, and when these are done the work of getting out shop drawings can go on rapidly. In the writer's office a standard shop drawing is 9 × 15 ins. Both beams and columns are printed in blank on bond paper, and only the details are filled in by hand. Fig. 10 is a reduction of one-third scale of one of these blank order sheets for columns. Similar blank order sheets are prepared for I-beams, etc.

This system was inaugurated by the Keystone Bridge Co., and gives excellent satisfaction, both in the drafting room and in the shop. No other class of detailing requires a clearer head or more constant care. The draftsman must always work in three dimensions, and many men find that difficult to do. The position that this kind of work is to have in the future is an interesting question for the engineering profession. Timber, stone and brick all have distinct limits within which they are available for constructive purposes. These new ma-

terials and these new methods come in to fill a want which the other materials and older methods could not meet, and it seems as if they had come to stay.

A NON-OXIDIZING PROCESS OF ANNEALING.

By H. P. Jones, M. E.

The writer has recently been able to conduct some experiments in connection with a non-oxidizing process of annealing iron or steel, and as the process has proved to be very practicable and efficient he feels warranted in bringing the results of the experiments to the notice of engineers.

The ordinary process of annealing, by means of which hard and brittle iron or steel is rendered soft and tough, consists in heating the metal to a good red heat and then allowing it to cool gradually. While the metal is in a heated condition the surface becomes oxidized; and although for many classes of work this scale of oxide is of practical importance, yet in some cases it is very undesirable and even necessitates considerable expense in its removal.

In order to prevent this oxidation many methods have been devised, and some of these, for special purposes, have met with more or less success. In nearly all of these devices use is made of a closed pot or retort, in which the metal to be annealed is placed, and then the retort and its contents heated to the required temperature in a suitable furnace. The amount of air, and therefore the amount of oxygen, contained in the retort is often diminished by filling the intervening spaces with sand, &c., and in some cases the atmosphere within the retort is rendered non-oxidizing by inclosing iron chips or filings, with which the oxygen combines. Another method, similar to the preceding, is to fill the retort with a non-oxidizing gas.

It is evident that, in order to be of value, a process of the latter character must be not only very efficient, but also practical and inexpensive; as far as the writer is aware, such processes have heretofore

Fig. 9. Column Sections with Fireproofing.

failed in these requirements. In those processes that have come to his knowledge the practice has been either to confine the gas in a retort containing the metal to be annealed or to maintain a constant flow of gas through the retort.

The first method is objectionable on account of its requiring a very strong retort, and also for the reason that it is almost impossible to prevent some leakage of the gas during the expansion in heating and a proportionate entrance of air during the contraction of the gas in cooling, thus resulting in some oxidation of the inclosed metal. The second method is objectionable on account of the quantity of gas required, which makes the process a very expensive one.

The process which will be described is one using a non-oxidizing gas, and is the invention of Mr. Horace K. Jones, of Hartford, Conn., to whom patents have been issued. The principal feature of this process consists in keeping the retort in communication with the gas holder or gas main during the entire process of heating and cooling, the gas thus being allowed to expand back into the main, and being, therefore, kept at a practically constant pressure.

Although the process is now made public for the first time, yet it has been in constant use for more than two years, and during this time several tons of metal daily have been annealed and returned from the retorts perfectly bright and at a very slight expense. A lot of several tons of steel has very recently been annealed by it for a steel company at New Britain, Conn., with entire satisfaction.

The retorts used are made from wrought iron tubes, and are of different sizes suitable for the work to be annealed. The gas used is taken directly from the mains supplying the city with illuminating gas, and while it may be expected that some of the constituent gases would produce a deleterious effect upon the metal, yet the annealed metal has been found to be practically uninjured.

Not only has the process been used in the annealing of work that it is desired to bring out perfectly bright, but it has also been the practice to re-anneal by this process all of the tool steel used in a large machine shop, although already annealed at the steel works where made, and the slight additional expense has been found to be more than compensated by the ease with which the steel is worked, and by the saving in wear of the cutting tools. It was also noticed that if metal which had been blued or slightly oxidized was subjected to the annealing process it came out bright, the oxide being reduced by the action of the gas. Practical use has been made of this fact in deoxidizing metal.

A very important feature of the process is the fact of its being purely mechanical, any workman of fair intelligence being able to produce the best of results. In the case of the ordinary process of annealing it is well known that even an expert work man often either overheats and burns the work or fails to make it soft enough; but in the case of the gas process a very little care entirely eliminates this uncertainty.

Although, as stated above, no injury to the metal could be observed after having heated it in contact

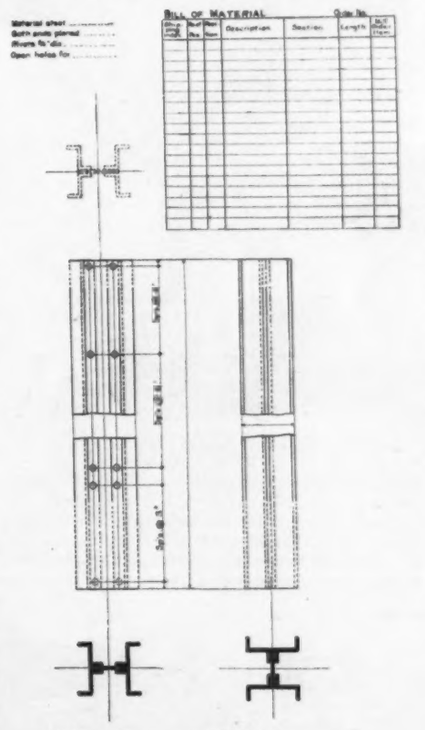


Fig. 10. Form of Blank Order Sheet for Columns. (Scale. $\frac{1}{4}$.)

with the illuminating gas, yet it is known that, at least theoretically, certain gases might have an injurious effect. It is not intended to discuss the effects of different gases upon iron or steel heated in contact with them; it will be sufficient to quote the conclusions arrived at by Mr. Henry M. Howe, who, in connection with the subject of non-oxidizing processes of annealing wire* states that "nitrogen should be perfectly harmless and efficient; hydrogen and hydrogen-bearing gases might be injurious. Carbonic acid would oxidize the iron; and even carbonic oxide would oxidize it slightly, but perhaps so slightly that its effects would be wholly removed in drawing."

In order to ascertain whether any injury to the metal, so slight as to have been overlooked in practice, had resulted from the use of illuminating gas, and therefore whether an advantage would be derived from the use of nitrogen as the non-oxidizing element, comparative tests were made of specimens of metal annealed in illuminating gas and of specimens annealed in nitrogen. The results of these tests were compared with the results of tests of specimens annealed in an open fire and cooled in ashes, and of specimens of the unannealed metal, and thus the relative efficiency of the gas process determined.

The illuminating gas used was taken from the mains supplying the city, as had been the custom, and the nitrogen was taken from a common gasholder of small size which had been filled with the gas obtained by means of a simple and inexpensive method used by Mr. Jones for the purpose. An analysis of this gas showed it to be practically pure nitrogen.

It is obvious that in order to make a fair comparison between specimens annealed in the two gases, the specimens compared must be from the same stock of metal and they must have been subjected to the same conditions as regards heating and cooling. To insure this uniformity the specimens were placed in two annealing retorts, one using illuminating gas and the other nitrogen, and heated side by side in the same furnace, care being taken to maintain an even fire. After remaining in the furnace the requisite length of time they were withdrawn and carefully cooled together.

The ordinary bending test for flexibility not having been found sufficiently refined to detect any differences in the specimens, it was determined to make the per cent. of elongation the basis of comparison. Experiments tend to prove that some gases, as for example hydrogen, affect the property of flexibility to a much greater degree than the elongation; but as the elongation is sensibly affected, and as an accurate numerical comparison between specimens with regard to flexibility would be exceedingly difficult, a comparison with reference to the elongation was considered sufficient for the purpose in view.

The specimens were made from steel wire .188 in. in diameter and were turned down to diameters of .156 and .150 in. Different lots of wire were tested in order to secure average results. The elongations were in each case referred to an original length of 1.15 ins.

The writer is aware that the use of such a short specimen invites criticism, as it seriously detracts from the value of the tests, as tests of metal; but the main object of the experiments was to effect a comparison between the methods of annealing, and the testing machine available was one designed for the use of small specimens only, and as an accurate comparison between specimens tested in this machine could certainly be made, it was decided to use the above length.

Several specimens of a greater length than 1.15 ins. were tested, and the per cent. of elongation was found to be the same as in the shorter specimens.

The elongations were noted for each additional load of 50 lbs., the measurements being carefully made by means of dividers. In order to more easily study the results of the tests, curves were plotted from the data obtained in the above manner, but it

* Metallurgy of Steel, 1891, p. 225.

Lot	Gas used.	No. test p'ces.	Diam. ins.	Breaking load. lbs.	Breaking load. lbs. per sq. in.	Elongation. total p. c.	Elongation. p. c. gained.	Treatment.
A..	Nitrogen....	4	.156	1,187	62,140	29.12	22.00	Specimens in retorts during 2½ hours, being kept at a good
B..	Illuminating	4	.156	1,206	63,110	28.08	20.86	red heat for 15 minutes, the remainder of the time being taken up in cooling.
C...	Nitrogen....	4	.150	1,092	60,000	28.00	19.20	Specimens were annealed in retorts with A and B, but
D..	Illuminating	4	.150	1,069	60,400	27.20	18.40	were from different stock, and were turned to a slightly smaller diameter.
E..	Nitrogen....	5	.156	1,095	57,320	30.88	23.76	Annealed in large retorts in connection with routine
F..	Illuminating	5	.156	1,090	57,070	29.09	22.48	work of the shop. Specimens in retorts during 20½ hours, being in furnace for 4 hours and cooling for 16½ hours.
G..	Open fire....	8	.156	1,205	63,090	26.76	19.64	Specimens were annealed at different times, being cooled in ashes.
H..	Unannealed.	5	.156	1,855	97,130	7.12		Specimens from the original stock, tested without annealing.
I...	Unannealed.	5	.150	1,490	80,790	8.80		Specimens from the original stock, tested without annealing.

is thought unnecessary to reproduce these curves here and the accompanying table of average results is substituted.

By a reference to this table it will be seen that the difference in total per cent. of elongation and in breaking load between the specimens annealed in nitrogen and those annealed in illuminating gas is very slight and the conclusion is at once arrived at that for most classes of work practically as good results may be obtained by the use of illuminating gas as by the use of nitrogen.

In the case of each lot annealed the use of nitrogen resulted in a slightly greater total per cent. of elongation, this gain being 1.4% in lot A B, 0.80% in lot C D and 1.28% in E F, while, with the exception of lot E F, the breaking loads were slightly greater for those specimens having the smaller percentages of elongation, as would be expected.

If the value of the metal after annealing be represented by the product of the breaking load multiplied by the total per cent. of elongation, the value would be slightly greater for the specimens annealed in nitrogen.

In the case of lot G care was used to obtain the results of actual practice, but it will be seen that the total per cent. of elongation falls much below that of specimens annealed in either of the gases.

If the specimens had been annealed in lime or in charcoal dust instead of being exposed to the open fire, it is probable that slightly better results would have been obtained. If the efficiency of the nitrogen be represented by 100 then that of illuminating gas will be 95 and that of the ordinary process of heating in an open fire and cooling in ashes will be 86.

In the regular work of the shop where this process was in use a very severe test was found, consisting in striking up plates of the annealed steel in a press, the die having many sharp angles and depressions, but the metal showed no signs of injury after this severe treatment.

A coal burning annealing furnace designed to meet the requirements of this non-oxidizing process has recently been introduced into one of the largest manufacturing concerns in England and is giving entire satisfaction. In this country both coal burning and oil-burning furnaces are in use, the oil-burning furnace being preferred where fuel oil is obtainable.

So far as known to the writer this is the only perfectly non-oxidizing process of annealing, and as it is an acknowledged fact that in many branches of manufacture such a process is urgently needed, it would seem that its simplicity, economy and efficiency should commend it to manufacturers.

THE LATEST IMPROVEMENTS IN PHOTO-MICROGRAPHY.

Considerable attention is being paid in the current term of the New York medical colleges to photo-micrography, in respect to original investigation by specialists and by students in class work. It is an exceedingly intricate process, the most difficult of all microscopic tests, owing to the high powers used. The slightest jar, the rumbling of a vehicle in the street below, is sufficient to alter the focus.

The accompanying cuts illustrate the latest improved Carl Zeiss apparatus, with some few of the "cultures" of micro organisms photographed by this process.

The principal feature of this apparatus consists in arranging the support of the microscope and its appendages in such a manner that they are, or may be, once for all accurately centered, subsequent adjustment being only necessary for the source of illumination. For the latter adjustability is imperative for obvious reasons. The apparatus, when once properly adjusted, is not subject to decentration.

The photomicrographic camera is mounted on two cast iron standards on a level with the projection apparatus. The camera, which is mounted on a light iron frame, slides backward and forward as a whole. The greatest length of the bellows is about five feet. This length may be shortened to any desired degree. The bellows consist of two parts. The part nearest the microscope may be fixed in a vertical or any other intermediate position. The front and back of this part may be moved independently of each other by means of a rack and pinion. The dark slides, which fit both parts of the bellows, are made to take plates 9 × 9 ins., and can be supplied with frames for smaller sizes.

In the movable dark slide for making exposure scales, the sensitive plate is arranged to slide behind a slit cut in a fixed screen, and upon it a series

Fig. 1. Latest Form of Microscope.

of narrow strips of the central portion of the object may successively be photographed with varying exposures. The focusing rod for turning the micrometer head from the distance back of the camera (Fig. 2) is arranged to slip on an upright column on a sole plate and is supplied with a Hookes' key. With the appliances for changing the objectives on the stand (i. e., the sliding objective changer, including the tube slide, objective slide and revolving nose pieces) only a touch of the micrometer screw with the rod is necessary for perfect adjustment. The original apparatus has been subjected to considerable reconstruction with the object of removing some of the difficulties attending manipulation, and also in order to render the apparatus still better fitted for projection on a screen, both with high powers involving the interposition of a microscope, and with very low amplifications, obtainable with special low power projection lenses of long focus.

The following modifications relate to the mechanical arrangement of the table where the microscope or projection stands, the source of light and the intervening auxiliary apparatus are mounted.

The projection table, with its appendage and the auxiliary apparatus is isolated from the camera stand. The latter is only required as in the ordinary process of photography, and not for projection. The table and stand are separate and only connected during photographic exposure. This arrangement affords the advantage that all adjustments on the projection table, both of the microscope and its appendages, may be made by the observer with ease and precision, while the apparatus also readily lends itself to the purposes of demonstration by projection.

By a very simple light excluding sleeve, and by the camera being movable, the connection of the two parts is readily effected in such a manner as to exclude every particle of external light. The projection table and appendage consists, first, of a wood base, supported by two cast iron standards fitted at one end with an adjustable base-plate upon which the microscope is to be placed; the middle portion of the wood base is occupied by a horizontal guide bar about 2 ft. long, while the other end of the base is left entirely free, in order to provide room for the lighting appliances. The base or sole plate is made to take and center any of the large inclinable stands.

Fitted to the bellows are projection eye pieces, which are used to project the image formed by the objective on a screen for demonstrating purposes or upon a photographic plate. They consist of a convex lens and a compound system, which is most carefully corrected both spherically and chromatically, on the principle of "apochromatic" lenses and is entirely free from secondary chromatic aberration and from difference of focus between the visual and chemical rays. A diaphragm is placed between the lenses for limiting the field, and the compound lens can be made to approach or recede from this diaphragm. The cap of the projection eye piece forms a diaphragm by which internal reflection in the body tube is entirely obviated. The aperture of this diaphragm is made to correspond with the greatest aperture of the apochromatic lenses. The designation of these eye pieces corresponds to those amplifications which they would yield if used for ocular observation.

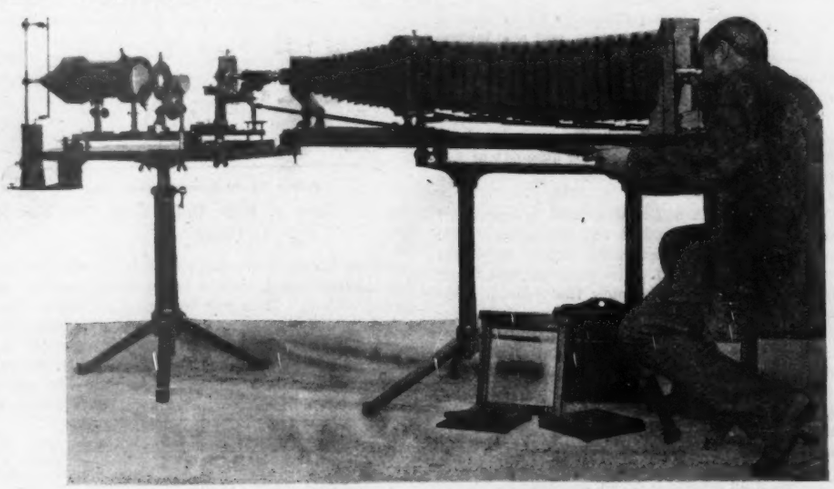


FIG. 2. APPARATUS FOR PROJECTION AND PHOTO-MICROGRAPHY.

The technical rules for determining the various powers we need not give, but as an example, an objective of 3 mm. gives, with the projection eye piece 2, an image magnified 1.000 diameters, at a distance of 150 cm., or about five feet. The image distance may be reduced or increased to any desired length. A new series of apochromatic lenses has been constructed specially for the apparatus.

The practical advantages of these new lenses are apparent. The natural colors of objects, even in the

more delicate tints, are truly reproduced by the objectives, and close to the margin of the field the images are nearly as sharp as in the center. By the great concentration of light afforded, these lenses permit of the use of very high power eye pieces without detriment to the brightness of the image or its accuracy.

These objectives differ essentially from all other microscopical lenses hitherto constructed by the simultaneous realization of, first, the union of three different colors of the spectrum in one point of the axis; and, secondly, the correction of spherical aber-

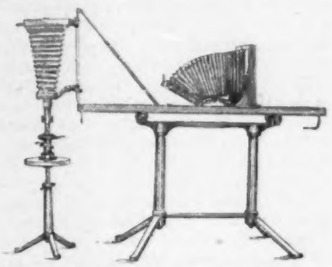


Fig. 3. Vertical Position of Photo-Micrographic Apparatus.

ration for two different colors in contradistinction to that for one in the brightest part of the specimen only.

Before the projection eye piece is placed the specimen plate. Directly opposed to the camera is the electric oxyhydrogen lamp which constitutes the illuminating apparatus. With it about 3,000 c. p.' are obtained with 16 ampères of current. The carbons are inclinable. A gas generator is provided for the continuous supply of oxygen, and also a copper gasometer with pressure gage for controlling the pressure of the oxygen. Instead of this powerful lamp, an argand lamp may be used with adjusted air inlet. Auer's incandescent gas light also yields a good illumination. The light is thrown from the electric apparatus through a condenser to a water bath, where electrical heat is absorbed, preventing the light thrown on the specimen from burning the same.

Through the water bath the light is conveyed to a set of lenses which absorb all but green rays. The reasons for using green light are, first, because photographic plates can be made sensitive to green light and, second, because specimens stained with blue or red offer the sharpest contrasts when illuminated with green light.

Through the absorbing lenses the green light passes through a diaphragm where it is concentrated, and next conveyed into a condenser, from which it is cast directly on the specimen plate.

The achromatic condenser is especially adapted for projecting a sharp image of the source of light in the plane of the specimen or object to be photographed. The projection lenses then convey the rays to the photographic plates and the picture is completed.

In the small vertical photo-micrographic camera the bellows have a length of about 18 ins. only. Either end of the camera may be moved up or down along the sliding bar by means of collar rings, and may be clamped in any position. The rod is pivoted in a socket and by this means the camera may be readily placed over the microscope, as shown in Fig. 3, or swung away from it. The apparatus is mounted upon a firm table. It has a separate double dark slide, and the auxiliary apparatus is the same as in the case of the larger camera already described.

The accompanying illustrations show specimens of germs in water, milk, and in disease. They are direct reproductions of the only complete set of micro-photographed germs extant.

The apparatus as thus described is manufactured by Carl Zeiss, of Jena, Austria. The accompanying illustrations show some specimens of the work done with it. They are direct photo-reproductions of photographs taken by Dr. Frank Abbot, Jr., instructor of the Loomis Laboratory, of the University of the City of New York, some of them being the first photographs of the kind ever taken in this country, and most of them being among the best ever taken anywhere. The original scale of the photographs was about twice that of our reproductions, but the photographs have scarcely lost any clearness by this reduction.

These advanced methods of photo-micrography are proving of practical value, as a means of accurately recording the results of investigation relative to the sanitary or non-sanitary conditions of air, water and sewage, as well as for medical and other like researches. They must hereafter prove of still more use in this respect. The latest devices show an improvement over former appliances in precision of workmanship, in the focusing of light, in the efficiency of the lenses, and in the better control of the effect of color on sensitive plates, which is an advance in photography. It has been demonstrated that the best pictures result where the source of light has been focused directly on the specimen, whether the light be natural or artificial; and that plates can be made sensitive to green color, which offers the sharpest contrast to specimens stained with blue or red.

The specimens may be magnified in area about 9,000,000 times, 3,000 diameters being the maximum enlargement.

We need hardly say that the elimination of hospital gangrene and other septic diseases (as they are now known to be), diseases which carry off thousands yearly, is due to the discoveries of bacteriologists, whose main reliance has from the first been the microscope.

Referring to the few samples of their latest work which we have selected for reproduction, the germ "Cyanogenus" (Fig. 4), is a micro-organism inhabhabiting the air, which is sometimes found in cow's milk, producing a blue color. It usually attacks milk which has been kept in a warm room, and grows luxuriantly in such milk, producing a slate color. The illustrated specimen was brought from Germany as a pure culture, and photographed here.

The "Spirillum volutans" (Fig. 5) is a micro-organism found in water which has been kept, and may be designated as a stale water microbe.

The "Spirillum flagellatum" (Fig. 6) is a new germ, discovered within the past six months, in water that had been kept at a temperature of 95° F. for some weeks.

The tubercular-micro organism (Fig. 7) is a pure culture of the bacillus of consumption, against which the Koch lymph was directed, which so unfortunately failed to accomplish all that was hoped. The particular culture illustrated was isolated from the lungs of a man who died in Bellevue Hospital.

The "bacilli lepræ," or leprosy bacilli (Fig. 8), were sent from Calcutta; but the first cholera germs to be satisfactorily photographed in this country, so far as known, are photographed in Fig. 9, and were obtained from Hop Sing, a Chinaman now on Ward's Island.

Fig. 4. Bacilli of Blue Milk Pure Culture.

Fig 5. Spirillum Volutans, from Stale Water.

Fig. 6. Spirillum Flagellatum, from Stale Water.

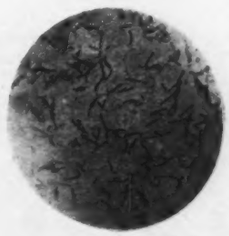


Fig. 7. Bacilli Tuberculosis. Pure Culture.

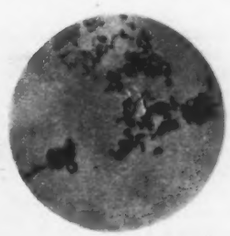


Fig. 8. Bacilli Lepræ. Pure Culture.

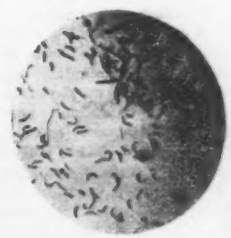


Fig. 9. Cholera Bacilli. Pure Culture.

THE VENTILATION OF TUNNELS.

The London "Railway News," in a late issue, describes the plan of Mr. C. ANDERSON, of Leeds, for preventing foul air in underground railways. An experimental length of half a mile has been tested on the Metropolitan Railway and the result is thus given:

The object in view is effected by making a connection between the smokebox of the moving locomotive and a stationary flue connected with exhausting apparatus. To this end a rectangular tube, having at intervals valves opening downward on its top side, is fixed between the rails. One end of this tube as now laid is closed, while the other end, half a mile away, is connected with a Roots blower driven by a small engine. The locomotive, which is one of the company's ordinary passenger engines, is fitted with a long sliding box, which is open on the under side and is carried beneath the engine. This slider is connected at its front end by a down chimney with the smokebox of the engine. There is a valve in this chimney and another in the ordinary funnel of the engine, both being worked by a hand lever, and being so arranged that on opening one the driver closes the other. Thus, when the train is in the tunnel the products of combustion can be directed into the tube, and when in the open they can be allowed to pass through the funnel into the air. The slider glides freely on the top of the rectangular tube, and it has a rib running centrally its whole length, which, as it passes over each valve, presses down a projection on it and opens it. The distance between the valves and the length of the central rib of the slider are so relatively proportioned that a valve is always open to admit the products of combustion to the tube.

The locomotive practically has two chimneys—namely the ordinary one which allows the products of combustion to escape upward into the air, and a second one passing down beneath the engine and in communication with the tube which is laid between the rails. When the train is in a tunnel the top funnel is closed and the lower one is open, thereby preventing any escape of the furnace gases into the tunnels. Where no tunnels exist the ordinary funnel will be used, and there will not be any pipes laid where the line is in the open.

The first trial of the length at Neasden recently took place in the presence of the officials of the company, when the efficiency of the system as a means of preventing the pollution of the atmosphere of underground railways was placed beyond question. With the exhausting machinery running, directly the locomotive came on to the tube the products of combustion were drawn into it and were soon seen issuing from the chimney of the exhausting station, half a mile away. The result was the same whether the engine was standing or running at its ordinary speed, the gases being drawn from the smokebox and delivered into the air. It was shown that the communication formed between the moving locomotive and the stationary flue was as perfect and satisfactory in effect as that of a stationary engine and boiler with its chimney, and that the gases from the locomotive furnace and the steam from the cylinders would be prevented from escaping into the tunnels and could be ejected into the outer atmosphere at any point.

MAIN RELIEF SEWER, BROOKLYN, N. Y.

[With Inset.]

We present in this issue the drawings and full particulars of the Green Ave. or main relief sewer in Brooklyn, N. Y. The purpose of this sewer is shown by the small map, Fig. 1. The drainage from the shaded area, forming a large part of the sewer districts on city maps, "L," "K," and "F," is now carried by the 7 sewers indicated by light lines to the East River above the Brooklyn Bridge, near the navy yard. In heavy rainstorms these sewers are not able to carry off the water, which then backs up in the area inclosed by the dotted lines, which area of the city is known as the "flooded district." The main relief sewer, indicated by the heavy black line, will take all the storm water and surface drainage from the shaded area, comprising about 1,300 acres, and will thus relieve the sewers in the flooded district. The location of the sewer was carefully selected in 1884, after a thorough examination of the conditions by the Engineering Bureau of the city, and was approved by expert engineers not connected with the city. The plans were prepared, and the work has been done under the supervision of Mr. Robert Van Buren, M. Am. Soc. C. E., City Engineer. Mr. L. Russell Clapp, M. Am. Soc. C. E., Assistant City Engineer, is the engineer in charge.

The original plan contemplated an outlet to the East River at the foot of Amity St., but this had to be abandoned owing to difficulties in acquiring the right of way for the outlet. The head of the sewer is on Greene Ave., a short distance beyond Marcy Ave., and the route is along Greene Ave., Hanson Place, Fourth Ave. and Butler St., to an outlet at the head of Gowanus canal. The canal discharges into the East River near its mouth, at the upper end of New York Bay. At the outfall are located a trap and catch basin which are throughly sealed at low tide. The basin is designed to prevent the passage of any solid matter into the canal, as well as to prevent the escape of noxious gasses. Provision is made for easily and quickly removing the accumulation of solid material, and only the storm water, practically free from solids and injurious elements, will reach the canal. The capacity of the sewer has been determined on the basis of a gravity discharge of one inch of rainfall per hour over the area drained, immediately reaching the sewer. It is possible that when in the future the area to be drained is closely built upon, and a possible increase of rainfall reaches the sewer that a greater discharge may occur. The construction of the sewer will permit this, as the grade line is so far below existing sewers whose surplus flow will discharge into it that a considerable head may be permitted which will greatly increase the velocity of flow through the relief sewer.

The work was let in two sections. The contract for section No. 1, the outfall sewer, from the canal to Fourth Ave., was awarded July 1, 1890, to Daniel J. Creem, the contract time being 200 working days. The contract for section No. 2, the main tunnel sewer, was awarded June 27, 1890, to Hart, Anderson & Barr, the contract time being 300 working days. Work was commenced on both sections early in July, 1890. Section No. 1 will be completed in January and section No. 2 in March, 1892. The approximate quantities and the contract prices are given in the following table:

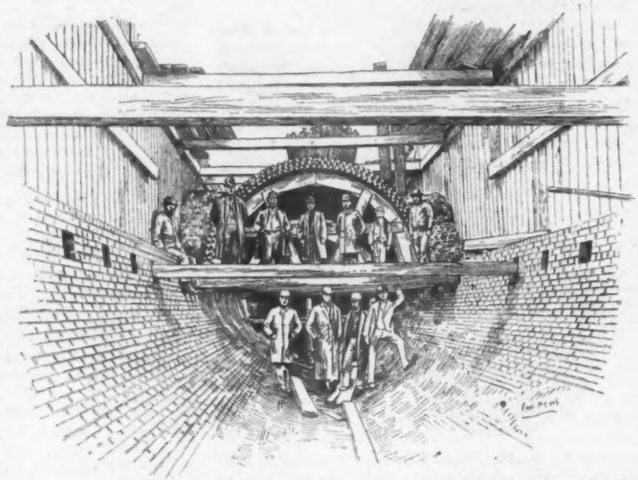
SECTION NO. 1.

2,000 lin. ft. 15 ft. main brick sewer	$28 per lin. ft.
1,000 " " iron beam covered main brick sewer	$34 " " "
1,000 cu. yds. brickwork for silt and trap basin	$6 per cu. yd.
46 tons wrought iron beams, straps and bolts for basin	$70 per ton
35 " cast-iron plates and columns for basin	$60 " "
435 piles for foundations of basin	$3.25 per pile
90,000 ft. B. M. lumber for basin	$38 per M. B. M.
90,000 " " " for coffer dam at basin	$38 " "
6,500 cu. yds. earth excavation, including removal and replacing of crib work at basin	$1 per cu. yd.
3,000 lin. ft. of 12-in. cement pipe drain under main sewer	$1 per lin. ft.
6 manholes complete, including iron head	$55 each
2 street basins complete, including iron pan	$100 each

SECTION NO. 2.

800 lin. ft. of 15-ft. main sewer tunnel	$69 per lin. ft.
4,400 " " 14 ft. " "	65 " " "
3,200 " " 12-ft. " "	50 " " "
1,000 " " 10-ft. " "	35 " " "
5,000 " " 12-in. cement pipe for drain	1 " " "
18 manholes	$800 each
2 street basins	100 "

On section No. 1 the main sewer was built in open trench, the trench being 1 ft. wider on each side than the exterior diameter of the sewer, and the bottom being excavated to the exact form and size of the lower half of the sewer. No serious engineering difficulties were encountered. The material is mostly sand, gravel and filled ground, but in one place a pocket of soft mud was met with, over which the sewer was built upon a timber grillage and with vertical brick sides up to the springing line of the arch. The profile of this section is shown in Fig. 2. Progress averaged about 300 ft. per month. Owing to the low elevation above tide level of a portion of Butler St. it was necessary to change the section of the outfall sewer from a circular to an approximately rectangular section, covered by brick arches between steel I beams, which rest on the side walls and are tied together by ¾-in. iron rods. The tops of these brick arches are covered with cement mortar ½-in. thick and then coated with hot asphalt pitch. The circular section, 15 ft. interior diameter, is shown in Fig. 3 and the rectangular sections in Fig. 4.

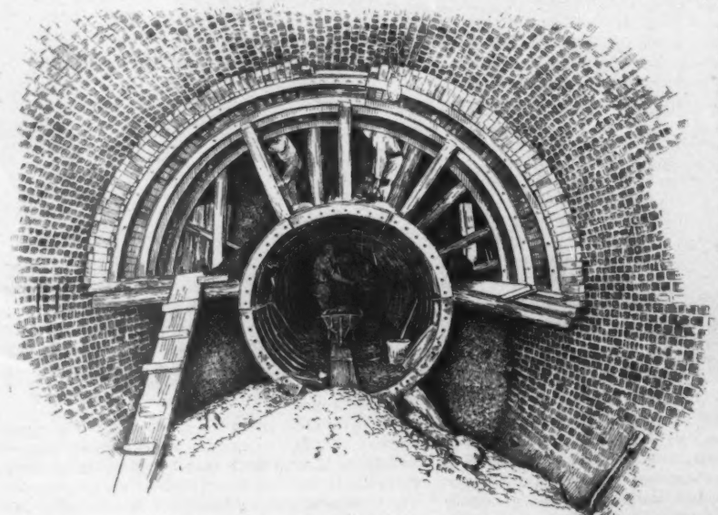


VIEW SHOWING CONSTRUCTION OF CIRCULAR SEWER IN OPEN CUT ON SECTION NO. 1, MAIN RELIEF SEWER, BROOKLYN, N. Y.

The silt and trap basin is 60 ft. long and 84 ft. wide, with the floor about 8 ft. below the bottom of the sewer and a height of about 14 ft. at the sewer end and 10 ft. at the outfall end. The outlet of the basin, consisting of 20 cast-iron pipes, 36 ins. diameter, built into the wall, has an area equal to that of the end section of the sewer, and is located 8 ft. below mean high water of the canal. It was at first intended to have a series of rectangular openings 10 ft. wide for the outlet the openings having cast-iron girders to carry the masonry, but the use of pipes was finally adopted, and the same arrangement was adopted for carrying the flow through the trap wall. The plans of the basin are given in Fig. 5. It was originally expected that the bottom of the basin would be on soft material, and a pile foundation, with grillage and plank floor, was therefore proposed, as shown in Fig. 6, and in detail in Fig. 7. A firm material was found, however, and the bottom was therefore constructed of concrete 3 ft. to 3 ft. 6 ins. in thickness. Provision is made by a corbeled string course in the walls and brackets on the iron columns for the support of beams to carry iron screens to catch any solid matter. These screens will be sufficiently strong to carry planks over which the material may be wheeled to one of the four manholes, where it will be hoisted up to the street.

The main sewer on Section No. 2 is in tunnel excation, the bottom of the tunnel being excavated to the exact size and form of the lower half of the sewer where the lower part is supported on concrete masonry; this work is paid for at $6 per cu. yd. for concrete, and $30 per 1,000 ft. B. M. for spruce plank foundation under the masonry. These prices were settled by the specifications. Where directed by the engineer, the drainage is effected by a 12-in. drain pipe, laid below the sewer and thoroughly imbedded in broken stone or gravel. After the sewer is built the drains are to be opened and then filled with such material as may be determined upon. The profile of this section is given in Fig. 8, and shows the materials met with, and the monthly rate of progress up to the end of November, 1891. The cross sections are shown in Fig. 9, and include 800 lin. ft. of tunnel 15 ft. diameter, 4,400 ft. of 14-ft., 3,200 ft. of 12-ft., and 1,000 ft. of 10-ft., the total length being 9,400 ft.

The brick masonry consists of the best quality of whole North River bricks, burnt hard entirely through and thoroughly wet immediately before being laid. Every brick is laid with full cement joints under the bottom, sides and ends, formed at one operation for each brick, and not made by working in the cement after the brick is laid. The concrete consists of 2½ parts of 2½-in. stone or hard brick, thoroughly cleaned, and mixed with 1 part of fresh hydraulic mortar. The cement mortar is composed of 1 bbl. of best quality fresh hydraulic cement to 2 bbls. of clean sharp sand, free from loam. The cement was specified to have a tensile strength of 50 to 60 lbs. per sq. in. after 30 minutes exposure in air and 24 hours immersion in water. All the brick masonry is laid in cement mortar, and the extrados of the upper arch is plastered with the same. The invert is laid upon 8-in. timber grillage in Section No. 1 and on a 2-in. plank cradle on Section No. 2.



VIEW SHOWING CONSTRUCTION OF SEWER TUNNEL BY ANDERSON & BARR SYSTEM; SECTION NO. 2, MAIN RELIEF SEWER, BROOKLYN, N. Y.

The manholes have walls of brick, 8 ins. thick to

a depth of 12 ft., and 12 ins. thick below that depth. The opening in the street is oval, 5 ft. 4 ins. × 3 ft. 8 ins. in the clear. Each is provided with a cast iron manhole head, cover and steps, the iron work being

FIG. I. MAP SHOWING LOCATION OF MAIN RELIEF SEWER, BROOKLYN, N. Y.

furnished by the city. As the relief sewer is intended for storm water only, the connections with cross sewers are made in the upper part of such sewers, thus not affecting the ordinary flow of sewage. This arrangement is shown in Fig. 11, but on Section No. 1 there are no connections, and the manhole is built as shown in Fig. 10. On Section No. 1 there are 6-in. vitrified or cement drain pipes worked into the walls of the main sewer, at an average distance apart of 10 ft., on all lot fronts, wherever directed by the engineer. These pipes are set with the inner end flush with the inside of the sewer, and are closed by inserting an earthen or cement cover.

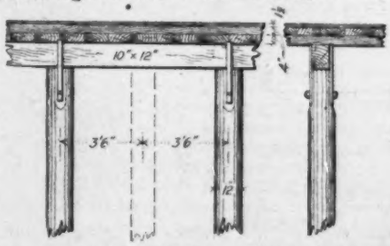


Fig. 7. Detail of Proposed Pile and Timber Foundation for Silt and Trap Basin.

The tunnel was driven from 7 shafts. The most serious difficulties encountered were in dealing with quicksand, boulders, loose dry gravel, and with water overhead from small street sewers. The loose, dry gravel was very troublesome, as it flowed easily, but the plan was adopted of turning water into it by a pipe, thus increasing its stability and rendering it easy to handle. This plan gave entire satisfaction. The material from the tunnel excavation, consisting mainly of gravel and sharp sand is hoisted to the surface in the dump cars, which are run out on a trestle near the shaft, and the contents dumped onto screens, the various materials being either used in construction or sold by the contractor. For removing the material from the headings there is a narrow gage track in the tunnel, with iron dump cars of the Hunt system, having outside flanges on the wheels. This plant is furnished by the C. W. Hunt Co., of New York. The contractor is required to keep the whole of the work in repair and good order for 9 months after the date of completion, and during that time to regrade, repave or remacadamize the carriageway of the street under which the sewer is built, if such work becomes necessary. The city will also make all repairs to sidewalks, stoops, etc., rendered necessary by any settlement of material due to the construction of the tunnel, but great care was taken to keep the amount of excavation as small as possible, so as to avoid any great settlement.

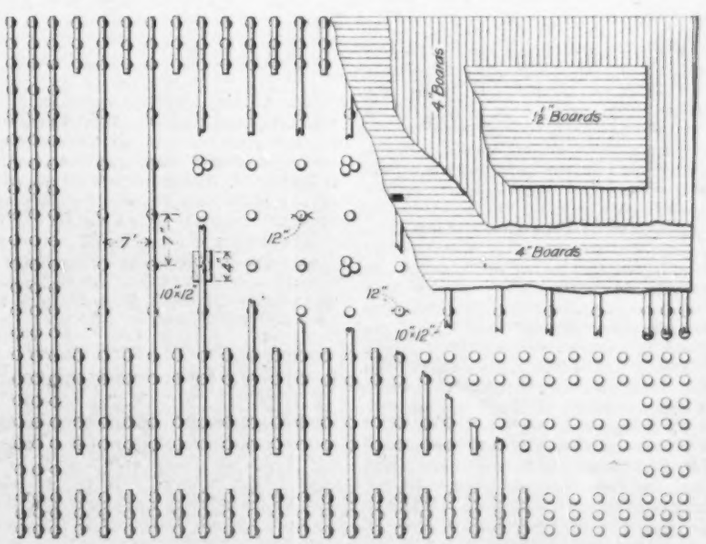


Fig. 6. Original Plan of Pile Foundations for Silt and Trap Basin.

The tunnel work on Section No. 2 has been done by the system of Messrs. Anderson and Barr for tunneling through soft and uncertain materials, which system had previously been successfully used in building the Knickerbocker Ave. extension sewer through a part of South Fifth St., Brooklyn, in 1885 and 1886. The following description of the method of tunnel construction under this system is abstracted from a report made in January, 1891, by Mr. L. Russell Clapp, the engineer in charge, to Mr. Robert Van Buren, City Engineer.

Shafts large enough for the proper conveyance of materials from and into the tunnel are sunk at such places on the line of the work as are most convenient for the purpose and of as little inconvenience to property owners as possible. From these shafts a small tunnel, technically a pilot, about 6 ft. diam., composed of plates of rolled boiler iron riveted to light angle irons on four sides, perforated for bolts and bent to the required radius of the pilot, is built into the central part of the excavation on the axis of the tunnel. This pilot is generally kept about 30 ft. in advance of the completed excavation. The material around the exterior of the pilot is then excavated, using the pilot as a support for braces which radiate from it and secure in position the plates of the outside shell, which holds the sand, gravel or other material in place until the concentric rings of brick masonry are built. Ribs of T iron, bent to the radius of the interior of the brick work and supported by the braces radiating from the pilot, are used as centering supports to the masonry. On these ribs narrow, lagging boards are laid as the construction of the arches proceeds, the braces holding the shell plates and incumbent mass being removed as the masonry progresses. The key bricks of arches are placed in position on ingeniously contrived key boards, about 12 ins. in width, which are fitted into rabbeted lagging boards one after another as the key bricks are laid in place. After the masonry has been in place at least 24 hours, allowing the cement mortar time to set the braces, ribs and lagging supporting it are removed. In the meantime the excavation, bracing, pilot and exterior shell, have been carried forward, preparing the way for more masonry. The top plates of the shell are first placed in position, the material being excavated in advance and supported temporarily by light poling boards; then the side plates are bolted to the top, and the adjoining side plates. In the pilot the plates are united continuously around the perimeter of the circle, while in the exterior shell the plates are used for about one-third of its perimeter on top, unless treacherous material is encountered, when the plates are continued down to the springing lines of the arch. This iron lining is left in place. The bottom is excavated so as to conform to the exterior lines of the masonry. The excavation follows so closely to the outer lines of the normal section of the tunnel that very little loss occurs, even in bad material, and there is no loss where sufficient bond exists in the material to hold it in place until the poling boards are in position; and there is less demand for packing outside of the tunnel lining than would be required by other methods of tunnelling. Exceptional safety to neighboring property is assured by this method.

In driving the east heading from shaft No. 2, at Flatbush Ave. and Hanson Place, a pocket of water about 20

ft. below the surface and above the tunnel was tapped, and, finding its way into the tunnel excavation, caused a settlement under the pipe sewer in Hanson Place. This pipe sewer had to be taken up, and the sewage flow was temporarily cared for by the substitution of zinc lined boxes, to be replaced by cement pipes as soon as the material in the trench was properly and permanently settled. The construction of the tunnel was delayed from the above cause, as work had to be carried on slowly and with more than ordinary caution while passing this collection of water. It was not unexpected, as the test shaft at St. Felix St. had showed a water bearing sand, which required a tight well curb to penetrate it. At shaft No. 2 a 6)-in. egg-shaped main sewer had to be supported, which was done very successfully. This sewer will be connected by an overflow into the main relief sewer.

The method of construction and general arrangement of the pilot and shell are shown in Fig 12. The following particulars in regard to the pilot and shell have been furnished us by the Cockburn Barrow & Machine Co., of Jersey City, N. J., which company supplied all the steel and iron work for this contract, amounting to several thousand tons.

The pilot was built of steel plates ⅝-in. thick, 12 ins. wide and 37½ ins. long, rolled to a radius of 3 ft. Steel angles 4 × 4 × ½ in. were riveted along all four sides, and the plates bolted together with ⅝ in. machine bolts. The plates weighed 136 lbs. each, and six of them were required to make one complete ring 6 ft. in diam. In bolting them together iron shims are placed between the horizontal joints to form a footing for the wooden braces for the shell which radiate from the pilot. The shell plates of the 15 ft. section of the sewer are of No. 10 steel, 12 ins. wide and 37 ins. long, with steel angles 2½ × 2½ × ⅜ in., riveted around the edges the same as for the pilot, and put together with ⅝ in bolts. These plates weighed 61 lbs. each, and 18 of them were required to make one complete ring 15 ft. in diameter. In the 12-ft. section the plates were of No. 12 steel, 12 ins. wide, with steel angles 2 × 2 × ¼ in. These plates weighed 30 lbs. each., and 17 were required to make a complete ring 12 ft. in diameter.

The following table gives the time account on Section No. 2 up to Nov. 1, 1891:

Summary of Time Account to Nov. 1, 1891; Showing Number of Days.

	Shaft No. 1.	No. 2.	No. 3. West.	No. 3. East.	No. 4. West.	No. 4. East.	No. 5. West	No. 5. East.	No. 6. West.	No. 6. East.	No. 7. West.	No. 7. East.
Superintendent	18	115½	144	162	.....	.....	.....	.....	145	.....	.....	.....
Bookkeeper	18	107½	191	227	.....	.....	.....	.....	13½	.....	.....	.....
Timekeeper	18	152½	197	233	.....	.....	.....	.....	210	.....	.....	.....
Chief Engineer	38	24	108	126	.....	.....	.....	.....	108	.....	.....	.....
Engineers	470	295	597	669	341	.....	52	.....	448	.....	224	.....
Foremen	403½	330	854	930	319	.....	72	.....	609	.....	225	.....
Carpenter	112	119	208	214	57	.....	25	.....	98	.....	29	.....
Platemen	2,308	1,510	2,934	2,883	1,406	1,364	154	142	2,638	2,517	773	733
Bricklayers	401	288	391½	567½	213½	209½	19	19	360½	385	109½	132½
Masons' helpers	434	285	610	594	389	377	36	35	532	630	290	244
Laborers	4,970	3,302	6,314	6,411	3,421	2,882	380	229	4,720	4,185	1,197	1,664
Watchmen	304	312	416	464	241	.....	57	.....	369	.....	164	.....
Bracers	50½	50	68	.....	42½	.....	18	.....	12	.....	12	.....
Teams	378	488	749	896	779	.....	144	.....	427	.....	460	.....
Carts	2	.....	.....	.....	9	.....	15	.....	42	.....	38	.....
Total days	9,935	7,378½	13,811½	14,305½	7,238	4,832½	972	425	10,681	7,517	3,572½	2,173½

TWO STREET RAILWAY MOTORS.

The Prouty street car motor is a "noiseless" steam motor, intended for a self-contained car and to haul a trail car. The following particulars are taken from the specifications for a 14-ft. car. The motor is under the front platform. The steam generator is to have a working pressure of 80 to 100 lbs., and is tested to 250 lbs. It is to burn hard coal or coke, and to be capable of making a 10-mile run without replenishing the fire. It is located on one side of the front platform, inclosed in an asbestos lined case, 40 ins. long, 30 ins. high and 20 ins. wide, with the firebox below the platform and 10 ins. above the ground. The water supply is contained in a horizontal pipe under the seats, with a capacity of 80 galls., and is supplied by a valve operated by the driver's foot. The pipe is inclosed in a section of the exhaust pipe. Thus the exhaust heats the feed water and the car, and then passes through a Prouty muffler and condenser under the car. The power transmission is by a vertical rocking lever, pivoted at the lower end under the front platform, with the upper end connected by an arm with the motor wheel, which revolves continuously. A sliding box on the rocking lever supports one end of rods connecting (one above and one below the car axle) with right and left clutches, giving rotary motion to the axle. The driver raises the sliding box on the rocking lever to start the car and increase speed, and lowers it to decrease speed and stop the car. The axles are connected by a belt to utilize the adhesion of the four wheels.

The Patton motor for street railways is a self-contained motor driven by electricity, which is generated by a dynamo driven by a gasoline engine on the car. The combination sounds rather complicated, but the arrangement is said to be simple and satisfactory. No wires, poles or power plant are required. The middle portion of the car is inclosed, the engine, dynamo, motor and an accumulator occupying a space 6 ft. square. The engine is of 10 HP., geared directly to the dynamo by an Evans friction pulley, no belts being used on the machine. The motor is worked ordinarily direct from the dynamo, which is wired to the motor, geared to the axle. The storage batteries are inserted on a branch circuit, and become charged by the portion of the current from the dynamo not used by the motor, which, when the load is light, is a large percentage of that generated.

When in ascending a grade or in starting, a larger amount of power is called for, the electromotive force of the dynamo tends to drop and the storage batteries furnish the extra current required by the motor until the load becomes normal. The dynamo is then capable of furnishing the required amount of current to the motor, and supplying a small surplus to the batteries, thus maintaining them always charged. Each car carries 100 accumulator cells, two volts to the cell, supplying current of 300 ampères, developing 80 HP. when needed.

When the car is descending a grade, carrying a light load, or standing still, the surplus current of electricity is thrown into the storage accumulators, to be used only when an excess of the normal power is needed. The accumulators always stand ready to take up the surplus current when the motor is doing but little work, and return it to the motor when more power is required. The batteries are also used to start the engine. Only one man is required to operate the car. The engine is run automatically, and is so governed as to require no attention other than keeping the oil cups full. The motor car weighs 14,000 to 16,000 lbs. It carries passengers and may be made to haul trail cars. The cost of operation is said to be about 17 to 20 cts. per hour, including wear of machinery. The motor is in service on the street railway at Pullman, Ill., and the company is under contract to construct quite a number of them, which will be in operation soon, on different city railways The motors are built by the Patton Motor Manufacturing Co., of Chicago, Ill.; President, A. B. Pullman; General Manager, Thos. Saunders; Superintendent, W. H. Patton.

THE TRIALS OF THE TORPEDO BOAT "CUSHING."

The last report of the Steam Engineering Bureau of the United States Navy, reviewed in our issue of Dec. 19, gives an account of tests made on the U. S. torpedo boat "Cushing." It will be remembered that this vessel is as yet the only torpedo boat in our navy, whereas each of the five principal European naval powers has over a hundred, as shown on page 572 in our issue of Dec. 12. However, it is probable that this deficiency in our navy will be eventually made good; and while Congress is deliberating over appropriations for this purpose it is well for the navy to learn what can be done with the one sample of this type of vessel which they already possess.

The "Cushing" was built by the Herreshoff Bros., of Bristol, R. I., the famous builders of high speed yachts; but her boilers are of the Thornycroft type, which has proved to possess great merits for torpedo boat service. In the summer of 1890 a test of one of these Thornycroft boilers was made at the New York Navy Yard. The test was made to determine the capacity and efficiency of the boiler when working at 250 lbs. pressure. The steam made was blown into an improvised condenser consisting of a 4-in. copper pipe leading overboard and opening axially into a wooden box 4 ft. long and 12 ins. square at one end and 15 ins. at the other. This box was secured to the hull in a horizontal position, about 20 ins. below the surface of the water. Thus arranged the apparatus became a huge ejector, through which the steam passed carrying with it water enough to entirely condense it, and that absolutely without a sound. Had the steam been blown into the open air, vocal communication would have been impossible. By means of a globe valve on the blow-off pipe, the boiler pressure was kept at 250 lbs.

The boiler when filled to steaming level weighs 11 tons. It has 2,451 sq. ft. of heating surface and 38 sq. ft. of grate surface, making the ratio 64.5 to 1. The boiler was tested under a natural draft and under forced draft with three different pressures of air. In the natural draft trial it was first attempted to work without the blowing engine. Although there was a strong breeze, the fire remained dead and the fire-room temperature ran up to 120°. The blower was then started, the batchway remaining open and the air-gage showing no appreciable pressure. In the forced draft trials the pressure of air in the fire-room in inches of water were ¼ in., 3 ins., and 4 ins. The test with 4 ins. pressure, however, was continued for only one hour, too short a period to give its results much value. In all these tests the quantity of coal burned was abnormally small, and all efforts to increase it were unavailing. The fire-room force consisted of raw recruits, picked out from the receiving ship, who had had no experience in handling forced draft fires. It is beyond question that better men would have produced better results. The following table shows the principal results of the tests:

	Pressure of draft used. Inapprecia ble.	¼ in.	3 ins.	4 ins.
Duration of test, hours	2.5	11.5	1.5	1
Revs. per min., blower	240	590	1,075	1,000
Temp. of uptake	371°	536°	655°	713°
Fuel per hour per sq. ft grate, lbs	7.58	24.12	40.23	66.32
Fuel per hour per sq. ft., heat. surf., lbs	0 117	0.374	0.624	1.028
Evap. per lb. fuel from and at 212°, lbs	11.90	9.72	8.84	6.51
Per cent. of moisture in steam	8.09	2.11	3.80	6.68

Progressive horse power trials of the "Cushing" were made on July 20, 1891, by a board headed by Assistant Engineer Harrie Webster. The "Cushing" has twin engines of the quadruple-expansion type with the low pressure cylinder double, making 5 cylinders in each set. The stroke is 1.25 ft. and the cylinder diameters are 11.25 ins., 16 ins. and for the second intermediate and the double low-pressure cylinder 22.5 ins. The trials consisted in running for four hours at four different engine speeds. The principal results are recorded in the following table:

	Average for hours. 1st.	2d.	3d.	4th.
Steam pressure in boiler, lbs	65.	98.8	173.3	218.8
Vacuum, ins	25.3	24.1	23.0	19.0
Air pressure, ins. of water	0.4	1.7	1.2	2.1
Revs. per min., starboard engine	205.9	240.1	298.8	328 3
Temperature, engine room	96°	103°	104°	107°
" fire room	129°	130°	143°	125°
Grate surface in use, sq. ft.	38.3	38.3	76 6	76.6
Total HP., both main engines	261.3	449.5	926.5	1,272.6
Total HP., main and auxiliary engines	286.1	484.0	971.2	1,336.2
Speed, knots per hour	13.08	13.4	15.42	17.5

Owing to lack of opportunity the indicators used in the above trial were not standardized, and the horse power given is therefore probably 3% to 10% in excess of the actual power developed.

The new monitor "Miantonomoh," lately commisioned is 259½ ft. long on the load water line, 55 ft. 10 in. wide, and has a mean draft of 14½ ft. Her displacement is 3,990 tons. She is fitted with twin screws and inclined compound engines capable of imparting a normal speed of 10½ knots. Her main battery, carried in two turrets, consists of four 10-in. breech loading rifles. Her secondary battery is made up of two 6-pdr. and two 3-pdr. rapid-fire guns, two 37 m. Hotchkiss revolving cannon and two Gatling guns. The "Miantonomoh" belongs to the coast-defense class of war-ships, though she is capable of crossing the Atlantic.

THE FATE OF THE "GREAT EASTERN."

In a late issue of "The Engineer" views are given of the famous "Great Eastern" during the process of breaking her up at Liverpool, and from the description accompanying these we make the following brief sketch of the career of this unfortunately conceived triumph of engineering skill:

The "Great Eastern" was built in 1853-59, at Millwall, by Mr. Scott Russell, from designs by Mr. Isambard Brunel. Her inception was due to the difficulty of maintaining coaling stations on the long route to India via Cape Horn, and she was designed as a ship capable of carrying sufficient coal from England to last the round trip. The ship was 680 ft. long, 83 ft. wide and 114 ft. over the paddle-boxes, and 58 ft. moulded depth. Her gross register was 18,915 tons, and she was to be propelled by screw and paddles with 3,000 HP. nominal credited to her engines An attempt was made to launch her on Nov. 3, 1857, but for three months she defied all attempts to set her afloat, and it was only in January, 1858, she was launched broadside on into the Thames.

She was built throughout of best Lowmoor iron, 10,000 tons of plates and 3,000,000 rivets being used in her construction. From the keel to 6 ft. above the 28 ft. water-line she was double from stem to stern with two perfect hulls, one within the other, 34 ins. apart. Above this the outer hull was continued to a height of 24 ft. and then connected with a cellular upper deck 30 ft. above the load water-line. The two hulls were connected by 35 longitudinal girders about 30 ins. apart in the bottom and 60 ins. apart at the bilges and up the sides, and this cellular space was utilized for water ballast. The interior of the ship and the cellular hull were divided into 11 separate water-tight compartments by 10 transverse bulkheads, and the hold was again divided by two longitudinal bulkheads 350 ft. long amidships, and 36 ft. apart; the space between these latter bulkheads and the sides was devoted to carrying the 12,000 tons of coal required for a voyage to India and back.

The cylinders of the oscillating paddlewheel engines were 74 ins. diameter, 14 ft. stroke and each weighed 28 tons finished. The paddlewheels were 58 ft. in diameter. The four screw-engine cylinders were each 84 ins. diameter and 4 ft. stroke, and weighed 30 tons each. The propeller was 4-bladed, 24 ft. in diameter, with a shaft 150 ft long and weighing 60 tons. The working pressure was 25 lbs. per sq. in., and the calculated speed was 15 knots per hour. She was designed to carry 4,000 passengers in all, or 800 first class, 2,000 second and 1,200 third class, with a crew of 400 men, a cargo of 5,000 tons and 12,000 tons of coal. Fitted up as a troop-ship she was to have a capacity for 10,000 men. The total weight of ship and cargo was over 12,000 tons, and fully laden she would weigh 27,000 tons. The total cost of the "Great Eastern" is given as $3,750,000.

In October, 1859, she was taken to Liverpool as a show ship and in June, 1860, she made her first visit to America, carrying only 42 passengers. She made an average speed of 12.2 knots and burned 2,876 tons of coal in 3,442 knots. Coming home she made 14 knots and burned 2,744 tons of coal. Though she was exhibited in America the voyage was financially a failure. She left Milford Haven again on May 1, 1861, for New York, with 100 passengers and came back with 212 passengers and a large cargo. She then went to Quebec with 3,000 soldiers and made a third trip to New York, starting on Sept. 11. In this voyage, 300 miles off Cape Clear, she disabled both paddlewheels and wrenched off the rudder head in a very heavy gale. Temporary steering gear was rigged up and she returned to Queenstown. She made several other runs between New York and Liverpool in 1862 and 1863. In 1864 she was chartered to lay the first Atlantic cable, and on July 15, 1865, she left the Nore with the cable on board. She laid other cables up to 1874, when she closed her mercantile career.

After lying idle at Milford Haven for some years, excepting her use as a show ship in 1886 at Liverpool, her owners concluded in 1888 to break her up. At the sale of the parts of the vessel in November, 1888, the sum of $200,000 was realized, and work was commenced on the dismemberment. The views now show her with little left save the keel, bottom and stem.

PERSONALS.

Mr. C. J. Clifford has been appointed Master Mechanic of the Calumet & Blue Island Ry.

Mr F. E. Dewey has been appointed Superintendent of the New York & New England R. R., vice Mr. R. B. Williams, resigned.

Mr. George C. Clark and Mr. Samuel Keiser, members of the Board of Directors of the Delaware & Hudson Canal Co., have resigned.

Mr. Charles P. Brotherton has been appointed General Manager of the Kansas City, Wyandotte & Northwestern R. R., vice Mr. E. Summerfield, resigned.

Mr. D. Morice has been appointed Division Superintendent of the Grand Trunk Ry., with office at London, Ont., vice Mr. Robert Larmour, resigned on account of ill health.

Mr. Henry W. Hodge, late assistant engineer of the Phœnix Bridge Co., has been appointed chief engineer of the Union Iron Works, with headquarters at 29 Broadway, New York.

Prof. Palmer C. Ricketts, of the Renssalaer Polytechnic Institute, has been appointed Chief of Engineers on the staff of Governor Flower of New York, with the rank of Brigadier-General.

NEW PUBLICATIONS.

THE PHOSPHATES OF AMERICA. Where and How They Occur; How They Are Mined, and What They Cost, with Practical Treatises on the Manufacture of Sulphuric Acid, Acid Phosphate, Phosphoric Acid, and Concentrated Superphosphates, and Selected Methods of Chemical Analysis. By Francis Wyatt, Ph. D.: New York; The Scientific Publishing Co.; 12 mo., pp. 187; $1.

The discovery of phosphate deposits in Florida two years ago, and the widespread speculation in phosphate lands which followed the discovery, have made the subject of phosphate mining and working one of much general interest In our issues of July 11, 18 and 25, 1891, we gave an account of the history and present status of phosphate of lime production, part of which was taken from a paper by the author of the above volume, whose experience in examining phosphate deposits as a mining engineer and expert geologist gives his words the weight of authority.

Certainly this book is a welcome addition to the scanty literature of phosphate production and manufacture; but it must be said also that it is somewhat disappointing in its brevity and its rather superficial treatment of the subject. A book on the phosphates of America ought to have space for some brief description of the phosphate deposits of Martha's Vineyard, of Alabama and of North Carolina, even though they have not yet proved of commercial importance. Moreover, the chapter in this work devoted to South Carolina phosphates occupies only 17 pages and that describing the Florida phosphates has but 20 pages. The last half of the book is devoted to a description of the manufacture of sulphuric acid and superphosphates, and a discussion of the analysis of phosphates with a description of methods employed by the author in sampling and analyzing them. This last chapter seems to be of more practical value than any other in the book.

The chapters on Canadian apatite mining and on the Florida deposits are profusely illustrated by half-tone process engravings from photographs. A few of them are very good; but a large proportion give absolutely no information of any value, and might better have been omitted. An error of the author's which the publishers ought to have corrected in editing the work is his constant reference to himself in the plural. It is a common misconception that a writer (especially an editor) is at liberty to use "we" and "us" instead of "I" and "me" at discretion; but it is really as out of place for Dr. Wyatt to write: "We have had occasion during the past two years to traverse every county on the Gulf of Mexico rom Tallahassee to Punta Gorda," as it was for the editor of a local paper in Colorado to say, in writing of his solitary ride up a mountain trail in a snowstorm: "Our animal stumbled at every step, and only by its sudden jolts were we assured whether we were on foot or on horseback."*

FOREIGN COMMERCE OF THE UNITED STATES. Report of the Chief of the Bureau of Statistics, for the year ending June 30, 1891. Pub. doc. 8vo. pamph. pp. 99.

This report is usually one of somewhat special interest, as giving comparative statistics for many years past for immigration and shipping as well as commerce proper, which latter term is made to include a good deal of tabulated information on prices, grain crops, etc., as well as commerce proper. We run over a few of the salient facts shown by the tables.

The immigration of 560,319 has been exceeded only in 1881-2-3; it is a large increase over last year. The largest increases are from Bohemia, Hungary, Italy, Poland and Russia, but the total immigration from all these countries is only 185,000. Faint signs of a check in the decadence of mercantile marine are visible. The American tonnage entering our ports in 1891 was 3.67 millions (24% of the total) in 1891, against only 2.92 millions (19%) in 1881. Our foreign commerce by rail is showing a tendency to increase rapidly, having been 73 out of 1,729 millions in 1891, the last being the culmination of a pretty steady increase from 1,000 millions in 1870, and 723 millions in 1857.

The values of the hundreds of different articles of export and import we cannot go into, nor the commerce of the different ports. New York has for 25 years held a fairly constant proportion of 65% of the total imports, but has fallen from one-half to about 40% of the exports.

The percentage of total exports which is free increased last year from an average of 34½% to 45½%. The average percentage of duty on all exports, both free and dutiable, fell from 29½ to 25½%, but the average duty on dutiable imports increased from 44.4% to 46.3%.

The proportion of the wheat and flour imports of Great Britain which comes from the United States has fallen with many fluctuations from 65% in 1880 to 38½% in 1891. A surprising fact is that the Canadian proportion in the same period has fallen from 6.63% to 2.70%. The wheat crop of the world for four years past is shown with much fullness for all countries. Our total commerce is 54½% with Europe (23% with Great Britain), 11.6% with Asia, and nearly all the rest with American countries. The tables of prices are some of them very interesting and valuable.

THE SOULANGES CANAL.—Reports of Thomas Monro, M. Inst. C. E., and others. With plan. Printed by order of Parliament. 8vo. pamph., pp. 82.

This is a series of reports upon the canal, lately ordered by the Dominion Parliament, to connect Lakes St. Francis and St. Louis, and thus avoid the Coteau, Cedar and Split Rock rapids in the St. Lawrence River. The canal would be 14 miles long and would be constructed for a 14-ft. navigation, at an estimated cost of $4,750,000. The reports deal with full details, alternative routes, borings, estimates of cost, etc

*Silver Plume, Colo., "Silver Standard," Dec. 21, 1889.

SOCIETY PROCEEDINGS.

MICHIGAN ENGINEERING SOCIETY.—The 13th annual convention will be held in the rooms of the Board of Public Works, City Hall, Grand Rapids, Mich., Jan. 19-21. The programme will include papers by Geo. S. Pierson, A Method of Sewage Disposal; J. H. Forster, Hydrographic Surveying; A. L. Reed, Development of Water-Bearing Strata for Irrigation; S. E. Jarvis, Pneumatic Street Railway Propulsion; Prof. W. H. Pettee, Building Stones of Michigan, A Recent Decision of the Supreme Court of the United States on the Ownership of Lake Beds; E. H. Mumford, Notes in a Rolling Mill; E. W. Muenscher, Easement Curves; and others. Head quarters will be at the Bridge St. House.

F. Hodgman, Secretary.

COMING TECHNICAL MEETINGS.

TECHNICAL SOCIETY OF THE PACIFIC COAST.
Jan. 1, Secy., O. von Geldern, 319 Market St., San Francisco.
SWEDISH ENGINEERS' CLUB.
Jan. 2, Secy., P. Valentine. At 231 Union St., Brooklyn, and 646 North 10th St., Philadelphia.
NORTHWEST RAILROAD CLUB.
Jan. 2, Union Station, St. Paul.
ENGINEERS' CLUB OF PHILADELPHIA.
Jan. 2, 1122 Girard St. Secy., H. Murphy.
CIVIL ENGINEERS' SOCIETY OF ST. PAUL.
Jan. 4. Secy., C. L. Annan.
ENGINEERS' CLUB OF KANSAS CITY.
Jan. 4. Baird Building. Secy., H. Goldmark.
WESTERN SOCIETY OF ENGINEERS.
Jan. 6. Secy., J. W. Weston, 280 La Salle St., Chicago.
ENGINEERS' CLUB OF ST. LOUIS.
Jan. 6. Secy., Arthur Thatcher, Odd Fellows' Building.
AMERICAN SOCIETY OF CIVIL ENGINEERS.
Jan. 6. Secy., P. Collingwood, 127 East 23d St., New York.
ENGINEERS' CLUB OF MINNEAPOLIS.
Jan. 7. Public Library Bldg. Secy., F. W. Cappelen.
ASSOCIATION OF CIVIL ENGINEERS OF DALLAS.
Jan. 8. Secy., E. K. Smoot, 808 Commerce St.
CIVIL ENGINEERS' CLUB OF CLEVELAND.
Jan. 8. Secy., A. H. Porter, 50 Euclid Ave.
ATLANTA SOCIETY OF CIVIL ENGINEERS.
Jan. 12. Secy., Parker N. Black, Capitol Block.
DENVER SOCIETY OF CIVIL ENGINEERS.
Jan. 12. Secy., Geo. H. Angell.
INDIANA ENGINEERING SOCIETY.
Jan. 12, 14. Purdue Univ., Lafayette, Ind. Pres., R. I Morrison.
NORTHWESTERN SOCIETY OF ENGINEERS.
Jan. 12. Occidental Block, Seattle. Secy., K. H. Warner.
CIVIL ENGINEERS' ASSOCIATION OF KANSAS.
Jan. 13. Secy., J. C. Herring, Wichita, Kan.
NEW ENGLAND RAILROAD CLUB.
Jan. 13. United States Hotel, Boston. Secy., F. M. Curtis.
ENGINEERING ASSOCIATION OF THE SOUTHWEST.
Jan. 14. Secy., O. H. Landreth, Nashville, Tenn.
NORTHWESTERN TRACK AND BRIDGE ASSOCIATION.
Jan. 15. Union Station, St. Paul.
MONTANA SOCIETY OF CIVIL ENGINEERS.
Jan. 16. Helena.
WESTERN RAILWAY CLUB.
Jan. 18. Rookery Building, Chicago. Secy., W. H. Marshall.
ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.
Jan. 19. Secy., J. H. Harlow, Pittsburg, Pa.
BOSTON SOCIETY OF CIVIL ENGINEERS.
Jan. 18. Secy., S. E. Tinkham, City Hall.
CANADIAN SOCIETY OF CIVIL ENGINEERS.
Jan. 21. Secy., H. T. Bovey, 112 Mansfield St., Montreal, P. Q.
ENGINEERS' CLUB OF CINCINNATI.
Jan. 21. Secy., J. F. Wilson.
SCANDINAVIAN ENGINEERING SOCIETY OF CHICAGO.
Jan. 21. Secy., T. G. Pihlfeldt, 113 Adams St.
SOUTHERN AND SOUTHWESTERN RAILWAY CLUB.
Jan. 21. At Atlanta, Ga. Secy., F. A. Charpiot, Macon, Ga.
NEW YORK RAILROAD CLUB.
Jan. 21. Rooms of Am. Soc. M. E., 12 W. 31st St.

ENGINEERING NEWS

AND

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D. McN. STAUFFER, A. M. WELLINGTON.....EDITORS
CHAS. W. BAKER, E. E. R. TRATMAN, M. N. BAKER, F. P. BURT, } ASSOCIATE EDITORS
GEO. H. FROST.....BUSINESS MANAGER

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ADVERTISING RATES, 20 cents per line agate measure. Schedule sent on request. Changes of advertisements must be in hand on Tuesday afternoon; new advertisements, Wednesday afternoon; transient advertisements, not later than Thursday noon. The last pages go to press early on Friday, and we shall be obliged if subscribers who fail to receive their papers promptly will notify us without delay.

In describing the system of working in use at the Howard St. tunnel of the Baltimore Belt R R. in our issue of Dec. 19, we stated that the method of advancing the tunnel adopted by Superintendent E. J. Farrell, by two bottom drifts in which the side walls are built, was believed to be used here for the first time. Our attention has since been called to the fact that Mr. Channing M. Bolton, now Chief Engineer of the Richmond & Danville R. R., used this system in 1872-3 at the Church Hill tunnel of the Chesapeake & Ohio R. R. at Richmond, Va. The work is described in Drinker's "Tunneling," p. 492. The main part of the tunnel was driven with a top heading, and ditches were excavated in which to build the side walls. Before lining it with masonry, however, a section of the tunnel about 120 ft. in length caved in. It was to drift through this fallen material, which contained considerable water, that the system above noted was adopted, and it was used with excellent success.

The first accident on record on the New York elevated lines, which is directly accountable to the existence of very sharp curves on the line, occurred on Sunday last. The truck of one of the engines, running bunker foremost, according to the usual practice in one direction, was derailed rounding the 90-ft. radius curve just above the Park Place station. The train was, as usual at this point, only running about five miles per hour, being approaching a station as well as rounding the curve. The truck wheels managed to get outside the wooden guard rails, which are not continuous around the curve, and plowed along over a dozen or so ties, doing no great damage but causing a block of considerable duration.

A collision soon followed between the fourth and fifth following trains. The natural inference is that it must have happened on one or the other of the two sharp curves which immediately preceded the derailed train; but it is a significant circumstance that it was not here but on the long tangent above that the accident occurred. The danger from the curves is a readily comprehended one against which the whole staff is on its guard. The derailment had no sooner occurred than danger signals were passed along around the curves and the very next train was stopped on the long straight line above them. But after four trains in succession had been duly stopped, the engineer of the fifth train, in broad daylight, on a dead straight track, after stopping at a station where he was notified of the block, and in the face of a red danger signal conspicuously displayed from the rear of the train ahead, deliberately "pulled out" and ran into the said danger signal and its attached car with such force as to derail two cars! The incident is another and forcible illustration of the inherent fallibility of the human mind and human muscles, a fallibility which must be reckoned with and guarded against in all safe systems of operating. It is entirely possible that the man who did this reckless thing was ordinarily as good and careful an engineer as there was on the line, and that he is now as much puzzled as anyone to understand how he came to be so careless.

At the last meeting of the British Society of Arts, Mr. James Dredge, of London "Engineering," and a member of the Royal Commission, delivered a most comprehensive and excellent address on the present status and future prospects of the Columbian Exposition of 1893. Our readers will remember that Mr. Dredge recently visited Chicago in his official capacity as a Commissioner, and it is evident from his address that he went over the field with unusual care and with all the experience gained by intimate contact with preceding great exhibits in Paris and elsewhere. His opinion is entitled to all respect, and is of interest to Americans, therefore, when he tells the society that the prospects of this Exposition are now assured, and that the executive board has proved itself fully capable of dealing both with the general plan and the innumerable details of the problem submitted to it. Mr. Dredge says, further, that while one year ago both England and the Continent viewed the Columbian Exposition with contemptuous indifference; to-day its extent and magnificence are no longer questioned, and it has taken rank by anticipation as one of the great international expositions of the century. Mr. Dredge says that the cordial reception of the British Commission in Chicago last September calls for the brotherly co-operation of all English manufacturers to aid as well as to compete in 1893. In the remainder of his address he deals minutely with the plans, progress and prospects of the Exposition.

Whatever opinions one may have on other grounds as to the capture of the New York Legislature by the Democrats, it is likely to have one result at which good citizens of all parties can rejoice. It will probably lead to a prompt re-enumeration of the population of the state, not in the middle of summer, when the population of New York City is scattered and greatly reduced, but in the winter, or early spring, when it is stable and complete, and thus put an end to the serious doubts which exist as to the correctness of the federal census taken in June, 1890. If that census was correct, the boast of the Chicago people that by 1900 or soon after Chicago may outnumber the population of the legal New York is not so entirely unreasonable. The real New York, however, we need hardly say, is a very different thing from the legal one. Chicago has our best wishes, and the whole country is proud of her growth and her achievements, but before she begins to regard herself as a rival to the true New York it will be well for her to outgrow the true Philadelphia and Boston, with which latter cities, and not New York, lies her real rivalry at present. We commend to her attention the following paragraph from the first page of Census Bulletin No. 63, as showing what the true metropolitan population is of four of our largest cities:

> The two square degrees between 40°-41° N. and 73°-75° W., comprising New York, Brooklyn, Jersey City and other large cities, contain 3,658,000 inhabitants. The square degree between 42°-43° N. and 71°-72° W., comprising Boston and its suburbs, has 1,233,000 inhabitants; that between 39°-40° N. and 75°-76° W., in which is most of Philadelphia, has 1,414,000; while that between 41°-42° N. and 87°-88° W., in which is situated most of Chicago, contains 950,000 people.

Since the death of Mr. John Roach the Cramps have easily stood at the head of American ship builders, and an article in the current "North American Review," by the head of that firm, and comparing "The First Cost of Ships" in America and Europe has special interest for that reason. The key note of the whole article may be found in the closing sentence, which we quote in full:

> If the current policy of naval reconstruction be pursued for another decade, coupled with a vigorous and consistent execution of the measures recently enacted in behalf of the merchant marine, the question which forms the subject of this paper will be asked no more; unless, indeed, its point should be reversed, and Englishmen be asking one another, Can we build ships as economically as they can in the United States?

Mr. Cramp declares unequivocally that if the question be, "Can you build a ship to do the work of the best existing Atlantic lines for the same cost?" to that question I would reply: "Yes, or within as small a margin as would be likely to prevail in a similar case between any two English shipyards." But Mr. Cramp also dwells upon the fact that there are ships and ships. Much to our surprise he declares that, while there are many shipyards in Great Britain, "so far as my observation enables me to judge there are not more than three or, at the outside, four yards which would be considered by any of the great steamship companies" for building a first class modern liner. For the construction of the British tramp or second class steamer Mr. Cramp expresses a supreme contempt, declaring it to be inferior to the standard of any of our shipyards, and so inferior as to be not worth competing with. As the class thus contemptuously dismissed has for years past handled about half the freight tonnage of the world with very fair safety and success it is an open question whether Mr. Cramp does full justice to its merits. In regard to our recent naval progress he is on surer ground, and all Americans will approve of his conclusions. He says, to pick out a few salient sentences only:

> Just 10 years ago the first Naval Advisory Board reported a general scheme of naval reconstruction, though actual construction was not begun until about two years later. We not only had to build ships of an even higher grade than their contemporaries abroad, but we had to create a new group of industries in every branch of the art of steel making to supply us with the necessary material.
>
> Under these circumstances American shipyards have built or are building about 40 naval vessels of the very highest and most effective class in the world; and this development has been crowded into a space of about seven years. With only the existing authorized construction in view this country will have [built] the third navy in the world within less than ten years from a starting point which may be described as zero!
>
> The disparity in cost of naval ships between our own and British yards, ton per ton, gun for gun, and performance for performance, has dwindled in seven years until in the case of the three latest battle ships the margin may be expressed by a very small figure. To illustrate the rapidity of progress, the law signed June 30, 1890, authorized the construction of these three ships "of about 8,500 tons displacement," to cost "not over $4,000,000." The vessels now building under this act are actually of 10,400 tons displacement, with a margin of over $800,000 each for fixed armor and other necessary deductions. . . . It must be a pretty poor American who is not proud of such achievements in so short a time.

The output of car coupler patents seems to be on the increase, the inventive genius of the country being stimulated, doubtless, by the wide publicity given to the bills introduced in the last Congress, and to the action on the matter taken by the Convention of State Railroad Commissioners and its committee. During the first two weeks in December, 15 car coupler patents were issued, of which four were for couplers of the M. C. B. type. The remainder were a choice collection of ingenious contrivances, some of them as remarkable for complexity as are their inventors for simplicity. It is hardly to be expected that the production of this class of car couplers will cease for years to come, unless the Fool-killer employs a large force of assistants. But the other class of couplers is deserving of more consideration, for their inventors are as a rule better posted as to the present status of the coupler problem. Careful examination shows, however, that these inventions generally tend in just the wrong direction. The apparent purpose of their designers is to introduce some additional detail in the M. C. B. coupler, it matters little what, which will give the inventor a claim to peculiar excellence over all his competitors. If the inventors could only understand how these "improvements" are looked at by railway men, they might turn their energies in some more profitable direction.

The first and greatest need in car couplers to-day is uniformity, not only in the contour lines but in the knuckles, and in the position and direction of motion of the unlocking lever, so that either in the night or in the day, a brakeman can know which way to move the lever to uncouple the car. The second need is strength and durability. The weight and tractive power of locomotives, the capacity of cars, the length of trains, the speed and the suddenness of stops, are all steadily and rapidly increasing, and the result of all is increased strains on the draw-gear.

Now the malleable iron used in M. C. B. couplers

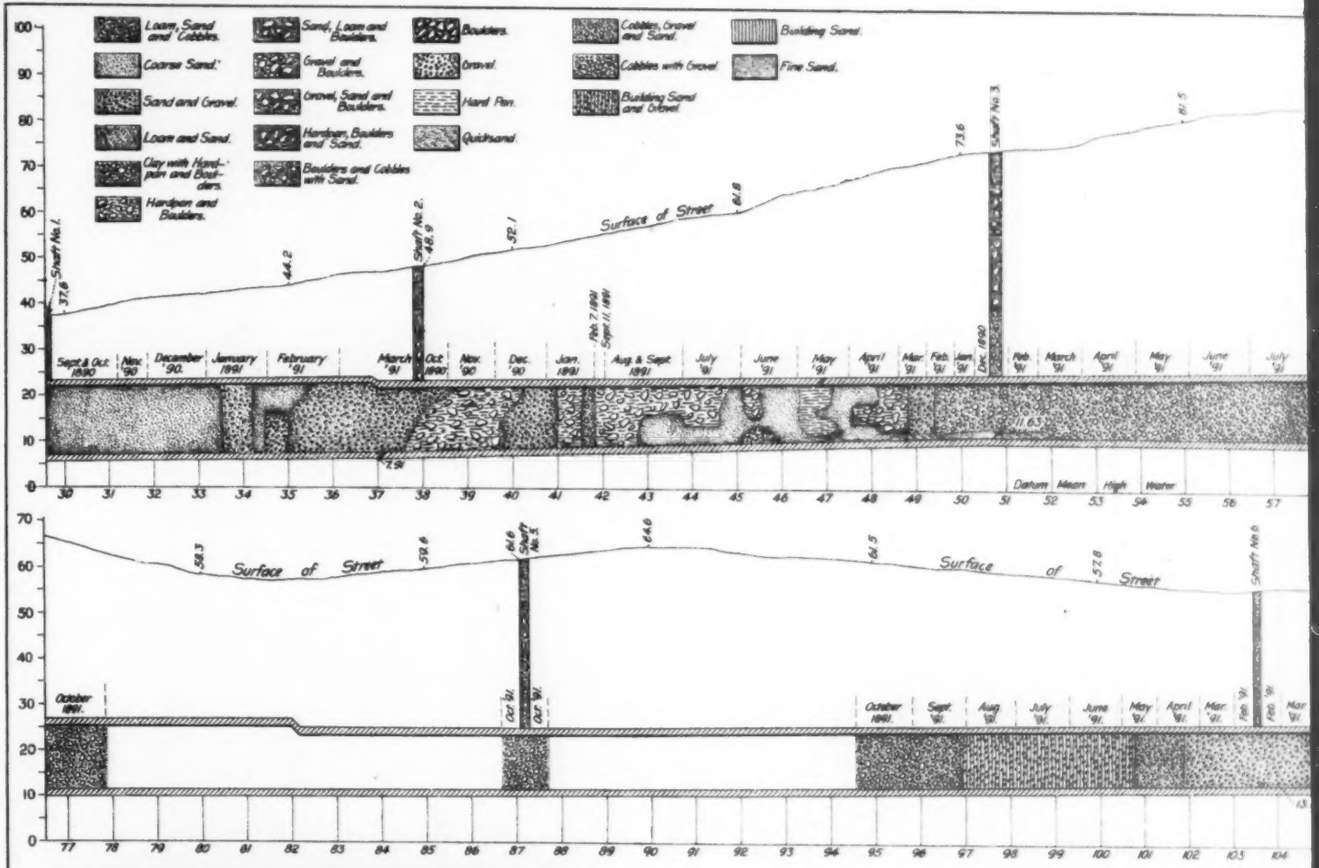
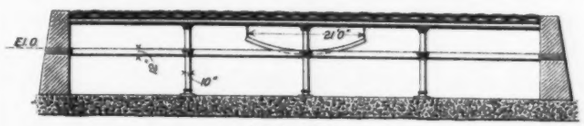
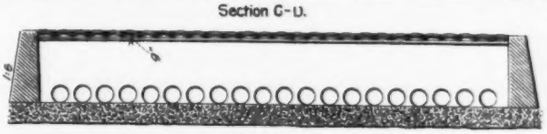


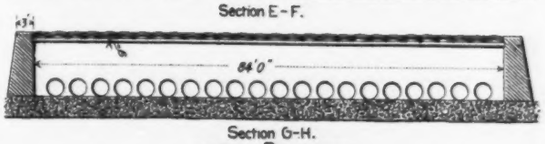
FIG. 8. PROFILE OF SECTION NO. 2. (TUNNEL).



Section C-D.



Section E-F.



Section G-H.

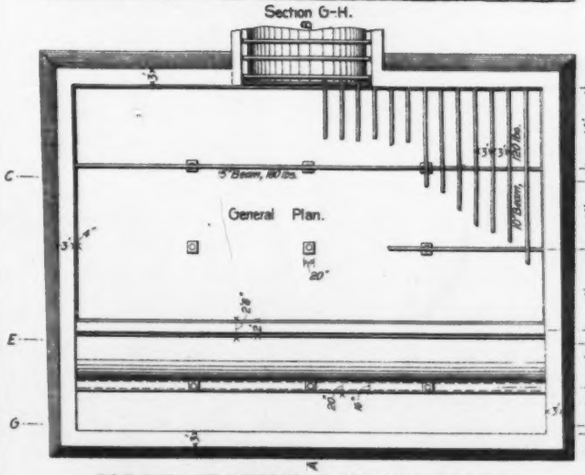
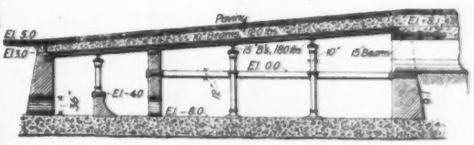


FIG. 5. PLAN AND SECTIONS OF SILT AND TRAP BASIN.



Section A-B.

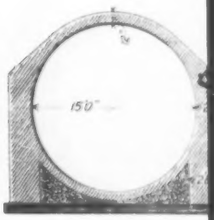


FIG. 3.
CIRCULAR CROSS-SECTIO
SECTION NO. I.

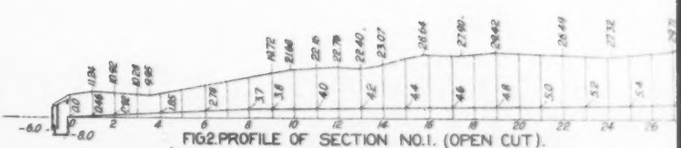
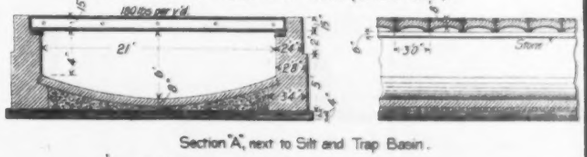
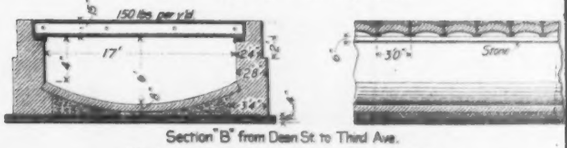


FIG. 2. PROFILE OF SECTION NO. I. (OPEN CUT).



Section "A", next to Silt and Trap Basin.

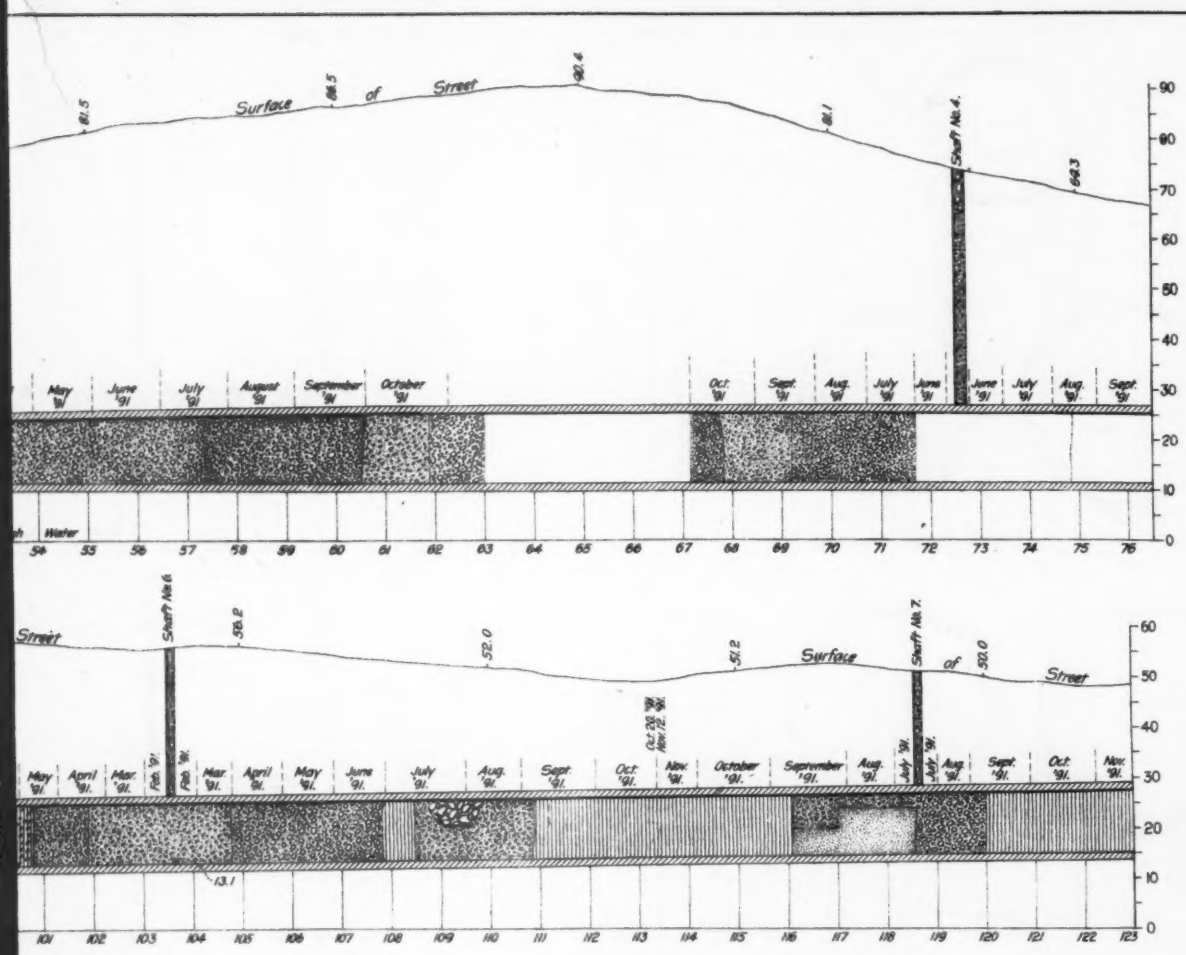


Section "B" from Dean St. to Third Ave.

FIG. 4. RECTANGULAR CROSS-SECTIONS,
SECTION NO. I.

MAIN RELIEF SEWER, BROOKLYN, N. Y.: PR

ROBERT VAN BUREN, CITY ENGINEER. L. RUSSEL



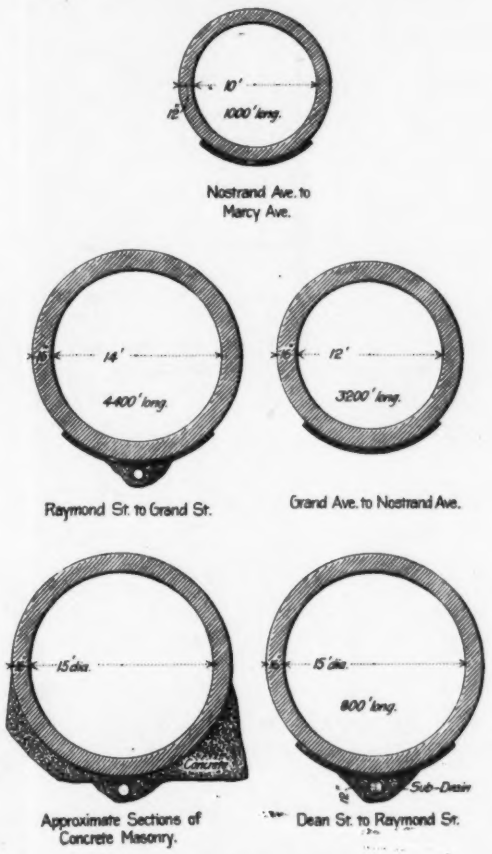


FIG. 9. TUNNEL CROSS SECTIONS, SECTION 2.

N NO. 2. (TUNNEL).

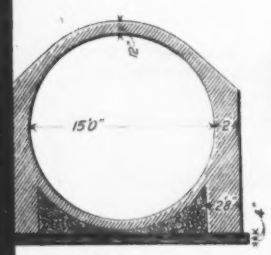


FIG. 3.
CIRCULAR CROSS-SECTION, SECTION NO. 1.

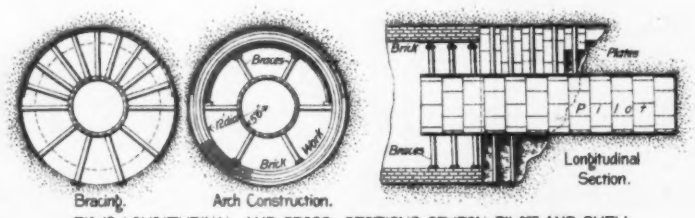
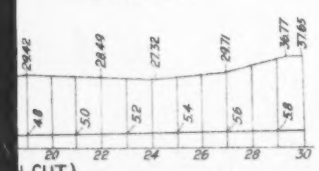
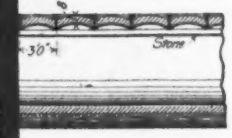


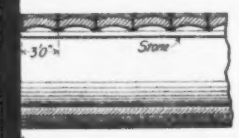
FIG. 12. LONGITUDINAL AND CROSS-SECTIONS OF IRON PILOT AND SHELL, SHOWING METHOD OF CONSTRUCTION BY ANDERSON & BARR SYSTEM



N CUT).



asin.



Ave.
ECTIONS,

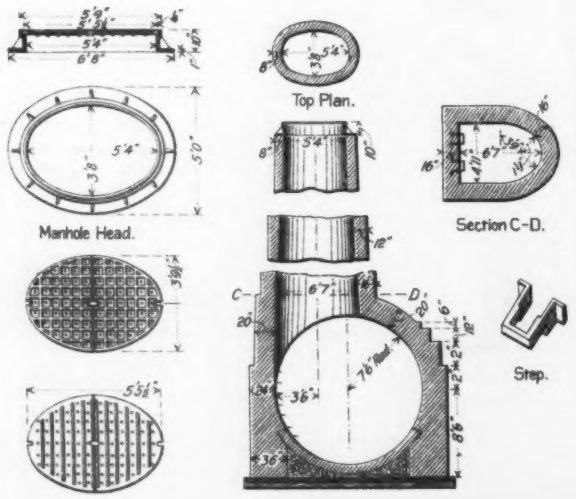


FIG. 10. ORDINARY MANHOLE, SECTION NO. 1.

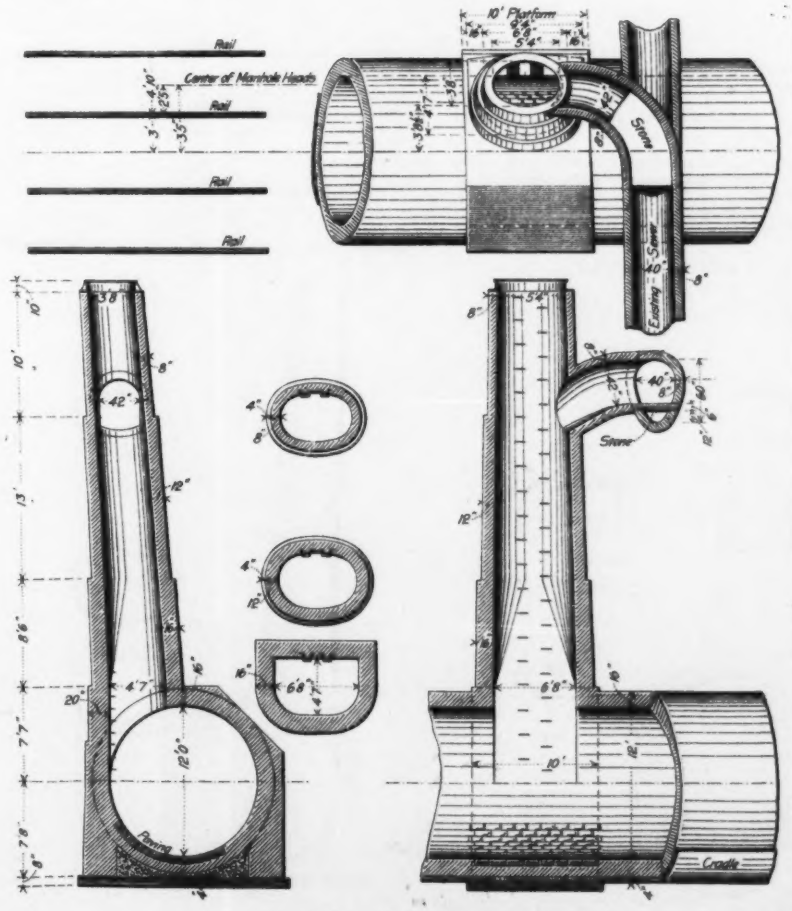


FIG. 11. MANHOLE AND SEWER CONNECTION FOR STORM WATER, SECTION 2.

, N. Y.: PROGRESS PROFILE, SECTIONS OF SEWER, MANHOLES, ETC.

L. RUSSELL CLAPP, ENGINEER IN CHARGE. ANDERSON & BARR, CONTRACTORS.

CHAS. HART & SONS, LITH., 98 VESEY ST., N. Y.

is a material having an elastic limit of perhaps 15,000 to 20,000 lbs. per sq. in., and an ultimate strength of 25,000 to 30,000 lbs. at most. Yet this material costs the railways, when put in the form of a coupler, from 3 to 5 cts. per lb. At the same time the steel rails in the track, which are made of material having an elastic limit greater than the ultimate strength of malleable iron, can be bought for 1½ cts. per lb. If an inventor desires to reap a fortune by solving the car coupling problem, let him put such material as this in the form of an effective M. C. B. coupler.

There is still a third important requirement for the successful car coupler, of which inventors are very apt to lose sight. It is that the coupler shall be absolutely reliable. In the railway service, to get out of order is a crime only less serious than breakage. To secure reliability, the greatest possible simplicity is required. If any inventor can still further simplify the M. C. B. coupler, his efforts will be welcomed; but the addition of any new detail or any increase in complexity in any part ought to have great practical merits indeed, to justify its introduction.

We begin this week the publication of an important series of articles on the use of mild steels for structural purposes, which we trust will be carefully read by those engineers who still consider wrought iron a better or safer material than low steel, as well as by those who, while they may have consented to the use of steel in works under their charge, think it necessary to treat it with unusual care, and still use wrought iron for details which involve much shop work or which are to be placed where they will be subject to shock.

It is quite true that the United States is far in advance of any nation in the use of structural steel; at the same time it is also true that a great many structures, some of them among the largest and most important, are constantly being built of wrought iron which might be built of steel with a saving in cost and an increase in strength. A poorer and more expensive material is being used in place of a better and cheaper one; and the reason is simply that those who have the charge of the work are not informed as to to the relative value of wrought iron and low steel. It will of course take a long time to rid the general public of the impression that the structural material known as "steel" does not, in some degree at least, resemble that other and older metal of which cutlery and tools are made.

Engineers, however, who are aware of recent progress, do not share the ignorance of the non-professional public. They know that structural steel differs from the steel of the cutler as copper differs from pig iron. They should understand that the metal which the genius of modern metallurgists has perfected to take the place of the hand-made wrought iron will endure a greater steady pull without breaking, will stand a greater shock without being bent or injured or broken, and will endure rough treatment with less injury than wrought iron; and further that these qualities have been proved, not only once but again and again, and not only on selected specimens of the metals, tested on the most accurate machines, but on full-size structures built of the different metals and loaded to their breaking point.

Still there are engineers whose inertia and ultra-conservatism prevents them from appreciating these facts; and it is not until the lesson has been often repeated, or perhaps until they find themselves outstripped by their better informed competitors, that they will venture to follow where they ought to lead the way. It is to this class that we specially commend the articles in question.

Again, the production of basic steel is a comparatively recent thing in America, and engineers with important structures on their hands are apt to hesitate before consenting to the use of a metal made by a process which utilizes iron ore rich in phosphorus. But the careful tests which we elsewhere describe were all made upon basic steel and wrought iron, and their results should give the fullest confidence to engineers who contemplate the use of basic steel; they deserve thorough study also by those engineers who have heretofore discriminated against basic steel in drawing specifications.

Besides offering thorough proof of the superiority of steel to wrought iron, the tests reported in this article give important evidence of the value of good workmanship in putting together iron and steel. Drilling the rivet holes instead of punching, and using a hydraulic riveter in place of handwork, increased the strength of a full size girder 21 per cent., and also increased stiffness and resilience. One of the experts in charge of the tests goes so far as to assert that good workmanship is the best possible guarantee of a structure's safety, provided it is correctly designed, being able even to offset the use of a poor grade of metal. It is to be noted that "good workmanship," as used here, indicates a shop practice much above the average, and one which few engineers have yet seen fit to ask for, and fewer yet have the courage to insist upon.

RAILWAY CONSTRUCTION OF 1890.

This has been a comparatively poor year for railway construction. The advance summaries of new railway track laid in the United States during the calendar year of 1891, which we present in the accompanying table, show that there has been a less mileage of new railway built during the year just passed than during any other year since 1885. According to our figures there have been constructed 4,093 miles of track since Jan. 1, 1891, bringing the total mileage of the United States up to 171,106 miles. These figures we believe to be substantially correct and certainly not exaggerated, although it is to be remembered that in order to publish our summary so soon after the close of the year many of our reports must necessarily be sent in some days before that time, and the tracklaying on lines where work is in progress has to be estimated. Delayed reports may also cause some slight changes from the above total. On the whole, however, we think that the final and corrected statement will not vary more than a hundred miles either way from the figures given, and probably not so much. The usual tendency against which the compiler of railway construction records has to be constantly on his guard, is to exaggerate the construction of new railways properly so called, i. e., those which are common carriers of both freight and passengers, by including more or less mileage of motor lines (carrying only passengers), or sidings and mining or timber roads (carrying only freight), as also by lending too much credence to hopeful reports of what is to be done before the end of the year. For example, in our issue of just a year ago we announced that the mileage of new construction in 1890 was 5,775 miles. Other records made public about the same time placed it at about 6,300. The actual mileage, as determined for Poor's Manual some six months later, was 5,738. It might appear that the greatest probable errors in such records would be errors of omission, but such is not the case.

The following table gives the mileage of track laid since Jan. 1, 1891, summarized by groups of states, together with the corresponding totals for each of the preceding four years, which we have added for the purpose of comparison:

Groups.	1887.	1888.	1889.	1890.	1891.
New England....	126	180	80	97	50
Middle.....	215	200	437	392	496
North Central....	1,751	806	687	619	464
South Atlantic..	836	1,174	1,095	1,119	1,026
South Central....	858	1,022	772	846	513
Southwestern....	5,118	1,509	851	901	433
Northwestern....	3,144	774	566	961	561
Pacific.....	691	929	604	611	549
Total.....	12 739	6,675	5,092	5,636	4,092

These figures include only track laid on extensions of steam railway lines upon which regular trains are to be run to do business as common carriers of both freight and passenger traffic; thus excluding lumber or mining railways not carrying passengers, and city lines carrying passengers but no freight. By including such lines the above totals could easily be increased several hundred miles. The figures of the above table are shown graphically in the accompanying diagram, from which their import can be more readily grasped.

Leaving the consideration of the work in detail until a future issue, when it will be discussed in connection with our detailed statistics and map showing in colors the location of all track laid during each of the last six years, we shall consider only some of the main features brought out by these records. As before stated, the mileage of new railway built this year is smaller than that built during any preceding year since 1885, when, according to Poor's Manual, only 3,131 miles of track were laid, it being nearly 1,000 miles less than was laid in 1889, which has the next smallest mileage to its credit, and only about one-third as much as was laid in the great year of 1887. This mileage, however, is fully as large, perhaps larger than the outlook during the early months of 1891 seemed to warrant. Moreover, it is probably fully as large as the best interests of the country demand. That railway construction has been overdone in many parts of the country in the five years just passed anyone who has observed the struggles of many of the large companies to stand up under their loads of unprofitable extensions will, we think, admit. It is true that many of these lines are at present paying properties, but many of them are not, and in either case it will be many years before the evil effect of their too early construction will cease to be felt by the companies which built them. The motive for thus rushing construction, of course, is to occupy the field in advance of other companies, and from that point of view such haste is doubtless in many cases good policy for the properties concerned, even when a temporary loss is involved.

It will be seen from the table and diagram that, with the exception of the Middle group, which exhibits a considerable gain, not only over last year but over the three years preceding 1890, each group shows a decrease from last year's figures. The Pacific group shows the smallest decrease and the Southwestern group the largest. The percentage of decrease in each of the other groups is about the same, that of the South Atlantic being somewhat less than for the others. This last mentioned group has this year, as in the two preceding years, the largest amount of new work to its credit. In this connection it is interesting to note how evenly construction has run in this group since 1888, when the era of rapid railway construction attendant upon the present industrial development of this section may be said to have begun. The difference between the greatest and least of these totals is only 173 miles, and during these four years the six States included in this group have added to their railway system 4,494 miles, or 24.8 per cent. of their total mileage.

The New England and Middle groups together exhibit a larger mileage of new track laid this year than for the year previous. The character of the work remains about the same. With few exceptions it consists of short branches and spurs built to develop local traffic.

The North Central group shows a decrease from the previous year's figures, as in each of the preceding three years. For the South Central group the totals for the five years are more irregular, but the new construction for 1891 is much smaller than for any of the other years covered by our table.

Similar decreases are shown by the Southwestern and Northwestern groups. The mileage of new road built in the first mentioned group in 1891 is only about one-half that of the previous year. It seems hardly possible that only 433 miles of track were laid in this group during the year, when one remembers the rush of construction in 1887.

Considering the United States as a whole, it is

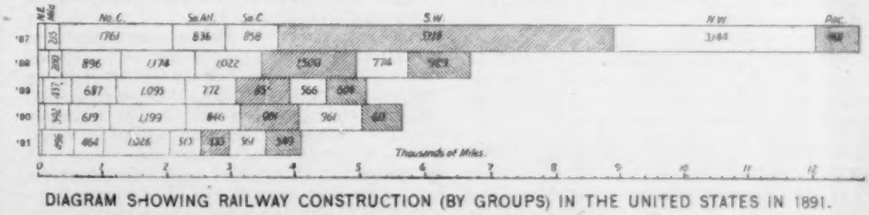


DIAGRAM SHOWING RAILWAY CONSTRUCTION (BY GROUPS) IN THE UNITED STATES IN 1891.

seen that the decrease in railway construction for the year just passed has been quite generally distributed throughout the country. From this it would seem that the decrease is due to the general financial depression of the last year, and not to the lack of opportunities for the profitable investment of capital in new railway construction in any particular section of the country. Whether work will be more active during the present year or not is still doubtful. It depends entirely upon the condition of the money market. At present the outlook seems favorable for increased activity in all industries. What may occur to disturb the growing confidence in Eastern money markets it is of course impossible to say. The attitude of the present Congress upon the monetary question will, as we have before said, be the most potent factor in this question. Should the present growing confidence in the money market continue, the outlook is good for a considerably increased activity in new construction during the ensuing year. On the other hand, if anything should occur to disturb this confidence, it is entirely possible that even less new railway will be built in 1892 than was built in the year just ended.

THE LATEST NEW YORK CENTRAL COLLISION.

The New York Central & Hudson River Railroad has almost, if not quite, the heaviest traffic of any trunk line railway in the world. All the railways of Great Britain and Ireland, aggregating 20,073 miles, made 313½ million train miles in 1890. The New York Central alone, with 442 miles of main line and 979 miles of branches, made one-ninth as great train mileage, or 33.2 millions. Taking the approximate proportion of 1 to 10 for traffic on main line and branches, (which facts that we will not go into lead us to believe is about a fair proportion;) 27.2 millions of this train mileage was made on the 442 miles of main line and only 6 millions on all the branches.

From these figures, by an easy deduction, we find that the traffic of the New York Central is a little over four times as heavy as on the average railway in Great Britain, without considering difference in weight and speed of trains. That is to say, the main line of the New York Central averages 168 trains per day over each mile of it, Sundays and all included, whereas the average British railway has less than 43 trains per day over each mile.

The Pennsylvania Railroad's main line traffic crowds the New York Central's close. Perhaps it exceeds it. Certainly it exceeds it when we take into account the comparative number of tracks, for it is to be remembered, in favor of the New York Central, that it is "the only four-track railway in the world (more correctly, the longest of the few four-track roads)." Along about the time when the United Railroads, of New Jersey, since leased to the Pennsylvania, first began to use the block system, in 1865, the New York Central was considering the policy which it afterwards adopted, of quadrupling its tracks.

Turning to the last return to the Board of Trade on "Railway Signal Arrangements and Systems of Working," we find that in respect to the use of the block signals in their different forms the British railway system stands as follows:

Extent to which the Absolute Block System was in Use in Great Britain on Dec. 31, 1890.

	England and Wales only.		United Kingdom	
System in Use.	Double-track.	Single-track.	Double-track.	Single-track.
Absolute block..	8,869	3,729	10,339	5,168½
Permissive do...	47½	.....	47½	25½
Telegraph, without block	13	.....	105	.....
Telegraph with train staff.....	....	64	.....	109
Telegraph without tr'n staff..	....	64	....	½
Only one train allowed on line at once.....	...	200½	.....	808
Train porter system.....		0½	.....	2
Train { With tickets.		271	.....	1 971½
staff { Without do.		66	.....	104
Unreported or other..... ...	74½	59½	367½	56½
Total mileage .	9,001	4,391	10,868	8,243
Per cent. Absolute block.....	98.5%	84.9%	95.5%	62.7%
Per cent. without any block system.	0.14%	5.9%	4.1%	10.5%

Away back in the '70's the condition was nearly as good. In 1874, 38 per cent. of the total British double track mileage and 26 per cent. of the single track was operated on the absolute block system. In England and Wales only 46 per cent. of the double track mileage was worked under the absolute block. In 1880, the latter percentage had risen to nearly 90 per cent. In 1885, 96 per cent. of the English double track mileage, and 63 per cent. of the total British double track mileage was worked on the absolute block system. The percentage of the interlocked switches has always been a little ahead of the block signal percentages.

When we keep in mind the vast increase of traffic which has occurred even in England since 1874 (the passenger traffic has very nearly doubled since that date and the freight increased about one-third), these figures mean that for nearly 20 years all the British railways having a traffic approximating to an eighth or a tenth of that of the New York Central has been worked on the absolute block system.

Naturally, the cost of installing and operating absolute block signals has been pretty well worked out by this time in England. The system was well established there as the best for heavy traffic as long ago as 1858. Some of the figures which were regarded as appalling away back in 1873 are interesting in this connection at the present time, when tremendous figures for the cost of block-signalling 444 miles of line are being put out to explain or palliate the long delay. The following may all be found in Board of Trade reports for 1873-4. After making all due allowances for the difference between English and American prices, between a four-track road and a double-track road, and between the plant of 1873 and the improved (but also in many ways simplified and cheaper) plants of 1892, the figures are of no little present interest. In England the same plants are much cheaper now than then.

The London & Southwestern Railway officers found that the plant cost $625 per mile, and the operation $300 per year.

The Midland found by experience on 50 miles, that construction cost $260 per mile, and maintenance $145. On another and more crowded part of its road, construction cost $600, maintenance of wires and signals $135, and wages of signalmen, etc., $300. It found the difference between the mere maintenance of signals of the new and old style to be that between $12.50 and $50 per mile.

The Great Northern figured out its costs per signal cabin, which is in many respects the more rational way. Its cabins averaged 1½ miles apart, and were 3½ miles apart as a maximum, according to volume of traffic. It found the cost to be about $1,000 per year per cabin with 2 men, and $1,350 with 3 men.

A road of less importance in the west of England which found it had sufficient signals and signalmen already on its line, found that $200 per mile per year covered its extra cost for operating under the absolute block system. One of the Scotch roads equipped itself with a 4½-mile block system at a cost of $80 per mile.

So we might go on and quote a lot more figures of this kind which were put out at that remote period when the use or non-use of the absolute block system was regarded in England as a matter of debate. That period has long since past. Its use is now a matter of course and, indeed, since last year is required by law; and accordingly it is less easy to find statements of just what the cost is of the interlocking and block signal plants. The expense is included with other indispensable items as a matter of course.

It must be confessed that when we turn to this country the record of past progress is less impressive. The Pennsylvania took the lead in operating under the block system in 1865-73, but for a good many years dallied somewhat unduly with the permissive block, which is better than nothing, but a poor substitute for the absolute block. Other roads were slow to follow, but nevertheless by 1884 there were nearly 500 miles of track operated under electric automatic block signals alone, besides some 400 miles of the Pennsylvania main line operated by signalmen only in cabins connected telegraphically with each other. So long ago as 1881, the Providence & Worcester road, 54 miles long, equipped its entire main line with automatic electric block signals, which in addition to the protection afforded by the block system proper, as used in England or on the Pennsylvania, gave notice if the electric continuity of the track was broken in any way, either by a broken rail, an open switch, a hand car or any other rolling vehicle on the track.

For example, about the same time the West Shore road was putting electric block signals on 16 miles of its line at West Point. They soon had occasion to test its benefits. A stray cannon ball from the cadets' practice battery struck and broke one of the rails, despite the safeguards against that danger, which had been supposed to be sufficient. Danger signals were at once set automatically in both directions, whereas otherwise an occurrence of this unusual kind might easily have caused a wreck.

Now, the Providence & Worcester, we need hardly say, has a quite insignificant traffic compared with a great trunk line like the New York Central. Let us contrast some of the figures in regard to the two roads.

Comparative Traffic of the Providence & Worcester and New York Central & Hudson River Railroads.

		Providence & Worcester		New York Central.	
		1881.*	1887.*	1881.	1890.
Miles operated	Main line,	44	44	442	442
	Branches,	22	6	1 005	977
	Total track,	109	137	2,622	3,841
Trains per year over m'n line†	Passenger,	5.700	7.300	9.450	18,300
	Freight,	5,527	4,990	22,400	22.250
	Total,	11,227	12.310	31,850	40,550
Earnings and expenses per mile of main line†	Gr'ss earn.	$22,350	$27.600	$59,700	$68,550
	Net "	7.150	8,965	23,750	31,850
	Expenses,	$15,200	$18,635	$35,950	$36,700

*The year 1891 is chosen as the year when block signals were introduced, and the year 1887 as the last year in which the road was indepently operated. It has since been leased to the New York, Providence & Boston.

†Computed by equalizing the branches, as having one-tenth of the traffic of the main line; i. e., by adding one-tenth of their length to the main line before dividing the train mileage by the miles of road.

It will be observed that the traffic of the Providence & Worcester Railroad was in 1881, when it block signaled its entire line with the most approved plant (which has been in use ever since with entire satisfaction), but a trifle more than one-third as heavy as that of the New York Central, and that its earnings were very much less than one-half.

Nevertheless, the Providence road had then and has still what would be regarded as a very heavy traffic if compared with the general average of the country, though it seems small compared with the Central's traffic. This being so, what has been its record in respect to accidents? We have taken pains to ascertain, and we find that *not a single collision of any moment has occurred on the road since the signal plant was installed ten years ago;* that the plant is still in use and working well, and that escape from a number of accidents which might have been very serious can be directly traced to it.

During this same period, what has been the record of the New York Central over an equal length of track, say between Spuyten Duyvil and Peekskill, only 31 miles? The collisions on this section alone may be counted by the dozens, and quite a number of them have been of the most serious nature. Even within the year just closed the road has had accident after accident, warning after warning, of the need of better safeguards against accident than those which have come down to it from antiquity, and which it still adheres to. Below Poughkeepsie alone, its direct loss from preventable accidents has been enough to equip the whole section with the best of signal plant several times over. The probabilities are that when the bills are all settled for the last addition to its long list of collisions, the circumstances of which are detailed elsewhere, the cost of this accident alone would do this.

Under these circumstances what has the New York Central done up to date toward putting itself on an equality with what the little Providence & Worcester had ten years ago in the way of safety appliances? We quote from the words of its General Superintendent in an interview with a reporter:

"I suppose your tracks are equipped with the block signal system?" suggested the reporter. "How could the St. Louis train get into the block with the other train, even if Herrick did fail to signal it?"

"No; we have no block system of signaling above Spuyten Duyvil [11 miles from the Grand Central station]. From the Grand Central to Spuyten Duyvil we have sig-

nal towers every 3,000 ft., and no train can go by one tower until the preceding train has passed the tower beyond. This system, which is an English invention known as the Sykes system, makes an accident like that yesterday absolutely impossible, and it is the only safe way of signaling. We are now extending this equipment, and the section from Spuyten Duyvil to Yonkers [4 miles long] will be ready for use in a day or two. From Yonkers to Peekskill [27 miles], where the towers will be 1½ miles apart—for a fast train about two minutes—the work is not so far advanced, but will be ready for use inside of two months. From Peekskill to Poughkeepsie [21 miles more, or 73 miles in all from New York] the towers will be 3½ miles apart. It was only yesterday that I signed the contract for building this section with the Johnson Railway Signal Co., of Rahway, N. J. When this system is all in there can be no more accidents like this."

"How about the road beyond Poughkeepsie? Is that equipped?"

"No."

"Is it going to be?"

"You mustn't ask me that. I am not the one who has the say about it."

The fact that the interlocking plant extends as far as Spuyten Duyvil is possibly traceable to the great disaster at that point on Jan. 13, 1882, near the beginning of the period of ten years which we have been considering. In this accident Senator Wagner and seven others were killed. The air brakes of the train were disarranged, and a brakeman was sent back, as at Hastings this week. He did not neglect his duty as did Herrick, but the red and white lanterns which he carried were mistaken for a mere caution signal, and a following train crashed into the rear sleeper, speedily starting a fire, in which, among other distressing incidents, a bride and groom on their bridal trip were burned to death before the eyes of the bystanders.

We trust the report is true that this last shocking disaster has at last awakened the controlling officials of the New York Central to the necessity for action, and that it is now practically decided on to block-signal the entire main line between New York and Buffalo. We know that some high officials of that line have been in favor of doing this for some years past. As a whole the policy of the Central has been much more liberal and abreast with the times in recent years than it used to be. Its bridges, tracks, buildings, engines, cars, and train service generally, have been greatly improved, and some of them represent the most advanced practice of the day. Whereas the road used to be behind in everything, it is now behind only in a few matters like block-signalling and interlocking.

But even supposing it to be true that the main line from New York to Buffalo is to be equipped at once with the best of signal plant, is the matter to rest there? Are we to wait till a like series of accidents on the Lake Shore, or the Erie, or the West Shore, or the Lehigh Valley, or the B. & O. or a dozen other lines, has enforced the same conclusion on their respective managements before they are equipped with proper systems of signals? Judging of the future by the past that is precisely what will happen with many roads, though the Erie and some others have shown commendable alacrity in anticipating the necessity before it is forced upon them. It is reported that the Board of Railroad Commissioners are going to take the matter in hand and fully investigate the recent accidents and the means by which they may be averted. It is well that they should. If they proceed intelligently they may accomplish much good.

The way to accomplish it, however, is not by direct compulsion or by mandatory orders, even if the commission have power to issue them. Publicity is the one thing needful to ensure reasonably prompt action. English experience in regard to its efficiency is absolutely conclusive. No one familiar with the facts will question that, except for governmental pressure, English practice in block signaling and interlocking would be far less advanced than it is to-day; but what has been the nature of this pressure? Nothing in the world but a cold-blooded yearly (or quarterly) tabulation of the existing facts in regard to each successive part of every line. No comment is made (as a rule); no other pressure is brought to bear. But the progress made by each road from year to year is thus brought before the world in black and white, in a way which is very unpleasant for those roads which are lagging behind unreasonably, especially when some accident occurs to call attention to their unreason. There lies before us a file of these blue-books. They run about 90 folio pages each, and some great systems like the London & Northwestern occupy six or seven pages each of closely printed tables. At the end of each are two or three tables of summaries by companies and by geographical sections, where the details are boiled down for ready digestion. Had the New York Central been compelled to stand cheek by jowl with the Pennsylvania in a table of this kind for the past 10 or 20 years, or even with the Erie, or with the Providence & Worcester, or with still other and less important roads it would have grown tired of its position long ere this, by the silent pressure of the types, and many lives and much property would have been saved. In matters of this nature, great is printer's ink, and very small the useful field for constables.

THE RIVAL HUDSON RIVER BRIDGE COMPANIES.

It is evident that some of the daily papers of this city, and probably some of our own readers as well, are considerably mixed as to the status of the two companies now before the public as proposing to bridge the Hudson River at New York. Items of news belonging to one are often accredited to the other. For the benefit of our readers it is well to state that there are two distinct companies, the North River Bridge Co., acting under the authority of an act of Congress, of which Mr. G. Lindenthal is Engineer, and the Consolidated New York & New Jersey Bridge Co., organized under a consolidation of old and new charters obtained from the states of New York and New Jersey, but as yet without authority from the United States to cross the river, an authority that is absolutely essential before anything can be done in the way of efficient construction.

The methods of these rival companies have differed radically from the start. The North River Bridge Co. was first in the field, and Mr. Gustav Lindenthal, its engineer, prepared and published on both sides of the Atlantic elaborately worked out plans, based on actual surveys, showing just how he proposed to erect a suspension bridge of 2,800 ft. clear span. These plans were so detailed as to furnish all necessary data for criticisms by engineers and for preliminary estimates of cost by capitalists. This North River Bridge Co., instead of attempting to deal with two notorious legislatures, went directly to Washington, presented its plans and purposes to Congress, and after full discussion of these on their merits the company obtained from Congress a rather unusual grant, which included not only authority to cross the river, but authority to condemn land for terminals in the two adjoining states, and, in general, all the legal powers which are necessary for the complete construction of the bridge and its terminals. That is to say, the North River Bridge Co. is organized under a charter that is full and complete within itself, without any further or separate State legislation. The company neither seeks nor intends to seek such additional sanction. In the light of the past experience of other great enterprises with the Legislatures of the two states concerned, the promotors of this bridge naturally preferred not to have to approach the state legislatures at all, if they could avoid it.

In the full discussion of the bill before Congress it was held by the ablest legal talent, and shown by many precedents in actual legislation, that under its constitutional powers to regulate commerce between the states, to establish post-roads and post-offices and to provide for the common defense and general welfare of the United States, Congress had ample authority to pass a bill giving every necessary power for the complete construction of this bridge to connect the two adjoining states. Since that authority was granted the company, in a businesslike manner, has been, and is now, quietly perfecting its plans, making surveys, obtaining property and gathering all the data necessary to present its project to capitalists in a complete and convincing form. It has no stock on the market, and all the preliminary expenses are met by the personal outlay of the promoters of the bridge.

The Consolidated New York & New Jersey Bridge Co., of which Mr. Charles Swan is the active representative, has launched its scheme in a very different way. Commencing work after the other company had fairly obtained the field, a curious charter was obtained from the New York Legislature and was then tacked on to an old New Jersey bridge charter, which was galvanized into life for this purpose. No attempt was made, or has yet been made, to obtain from the Government the right to cross the river, notwithstanding the fact that unless this authority is obtained every dollar invested in the scheme will be absolutely wasted. From the very start every move of this company was given to the press almost daily in carefully worded statements; plans for terminals in New York were elaborated; plans for rapid transit in this city was made a part of their scheme, and the Postmaster-General was promptly advised of their means by which they expected to greatly improve the distribution of mail matter in New York City, and his advice asked on them. In fact, every feature of the scheme was exploited, saving the one essential feature of a bridge across the Hudson. So far the public has never seen even an outline of the plans which this company proposes for this important structure, nor has it had any but the vaguest hints as to what kind of a bridge is proposed. The public is notified in the New York "Herald" of Dec. 20 that "the big bridge is started," that land is bought in New Jersey and that ground will be broken "this week," &c. Meanwhile the public must yet take the plans for "the biggest bridge on earth" on faith, the stock books are open and they are invited to invest in this "blind pool."

A comparison of the financial methods of the rival companies is also interesting. The North River Bridge Co. is wise enough to see that before an enterprise involving the expenditure of from $60,000,000 to $80,000,000 can be honestly and successfully launched something besides printer's ink and wind is necessary. In enterprises of a great magnitude like this, everything depends, not upon the sale of isolated small blocks of stock to an uninformed public, but upon convincing great capitalists of the feasibility and future of the project. Before the latter can be done every detail of plan must be worked out, every item of cost estimated upon sound data and traffic problems so carefully and exhaustively studied that the scheme can successfully stand the searching inquiry into its intrinsic merits that capitalists will surely inaugurate before putting money into it. It is worse than folly to invite general investment before this is done. And wide publicity of the exact location of proposed terminals and of other construction details is just the thing the business man will not seek until he has secured a considerable portion of the real estate necessary for his purposes. Nor will the promotor of a bona fide bridge take active steps in raising capital until he is fully informed as to the total cost of his scheme. In other words, the bridge company that makes the most noise and keeps itself most prominently before the public, through the medium of the daily press, is not necessarily doing the most efficient work in the direction of the actual construction of a bridge across the Hudson River.

Since the above was in type the contrast which we have pointed out between the methods of the two companies has been illustrated in a somewhat absurd way by the "breaking ground" procedures which are described as a matter of news in another column. So far as this journal is concerned it is equally friendly to either of these corporations, so far as they give evidence of equal good faith and earnestness in their alleged purposes. We should be sorry, indeed, to see any design carried out in which symmetry and dignity of appearance are ignored, or in which the river channel is needlessly obstructed; but the cost of a bridge across the Hudson must in any case be great, the need for it is also great, and we favor now and shall continue to favor that company which seems most likely to bridge the Hudson, as soon as it clearly appears which company it is. But the spectacle is not impressive of a few handfuls of projectors trying in vain to find each other in the open country, turning over a single sod in a pouring rain storm, and then adjourning to a water tower near by to make speeches to each other all before they have secured either money, plans, contracts, plant or power to build a bridge. Not thus, as a rule, are great enterprises inaugurated by those who are to carry them through to successful completion.

LETTERS TO THE EDITOR.

DISCHARGING CAPACITY OF WATER MAINS.

Sir: I inclose a diagram I have devised for readily solving such problems of the discharging capacity of water mains as occur under ordinary conditions of distribution. This diagram has proved quite a labor saving device, while the results obtained are rather more accurate than I had hoped for when I started to work the thing out. The co-ordinates from which the curves are plotted have been calculated on the assumption that the pipe line is laid perfectly straight and true to line and grade, also that the inner surface is clean and smooth—a condition of affairs that never strictly obtains in practice. Therefore, results obtained must be modified to suit any particular case as experience would dictate.

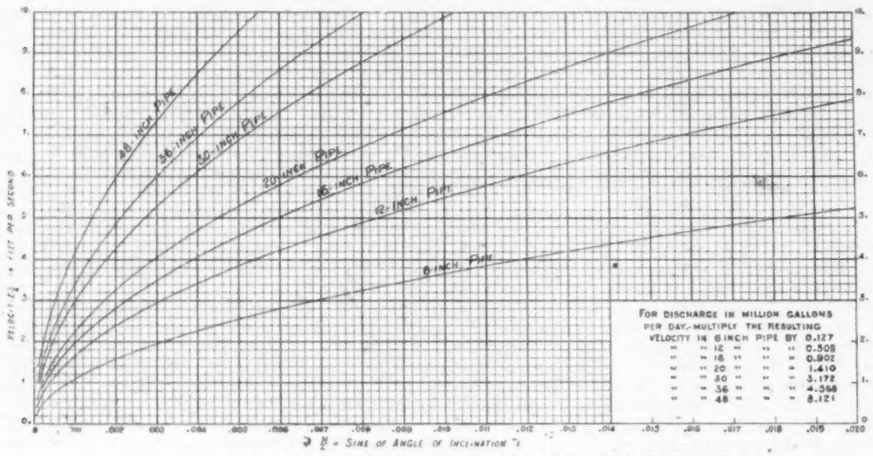

48-INCH PIPE
36-INCH PIPE
30-INCH PIPE
20-INCH PIPE
16-INCH PIPE
12-INCH PIPE
8-INCH PIPE
FOR DISCHARGE IN MILLION GALLONS PER DAY.-MULTIPLY THE RESULTING VELOCITY IN 6 INCH PIPE BY 0.127
" " 12 " " " 0.508
" " 16 " " " 0.902
" " 20 " " " 1.410
" " 30 " " " 3.172
" " 36 " " " 4.566
" " 48 " " " 8.121
VELOCITY IN FEET PER SECOND
$\frac{H}{L}$ = SINE OF ANGLE OF INCLINATION

DIAGRAM FOR CALCULATING DISCHARGING CAPACITY OF WATER MAINS.

EXAMPLE.

What is the discharge from a 20-in. main, 9,000 ft. long—loss of head 4.2 ft. Here $\frac{H}{L}$ = .00047, whence V for 20 in. pipe = 1.5 and 1.5 × 1,410 = 2,115,000 gallons per day. Actual discharge was rather less than 2,000,000 gallons, but the main had some bad horizontal and vertical curves which would undoubtedly reduce the flow somewhat. As a general statement pipes laid with ordinary care will give an actual discharge of from 5% to 10% less, while badly tuberculated pipes may give fully 25% less than discharge computed from diagram. Very Respect'ly,

James Duane,
Eng. in Charge Laying Croton Pipes.

New York, Dec. 14, 1891.

WHICH IS "THE NORTHWEST POINT?"

Sir: For the benefit of a number of interested parties, will you kindly state what is legally, and also in common practice, "the northwest point" of the lake shown in the inclosed figure?

The treaty establishing the boundary of an Indian reservation defines the portion in question as follows: " . . . to the most southerly end of Quinaielt Lake; thence northerly around the east shore of said lake to the northwest point thereof; thence in a direct line, etc. The Surveyor-General considers that the west end of the most northern course of the meander line of the lake, A, is the northwest point. This would seem equivalent to the most northerly point.

As the treaty is worded, the northwest point is to be reached by going around the east shore, no mention being made of the north shore.

It is known, however, that no survey of the lake but the present one has ever been made, and the commissioners who negotiated the treaty had no knowledge of its outline.

A number of settlers after consulting local surveyors, with whom I concur, took up claims along the north shore as far as the point marked B, and are now uncertain whether they will be allowed to remain.

Tacoma, Wash., Dec. 19, 1891. „ Quinaielt."

[This interesting case is one of those frequent instances of ambiguous description where, if there be any evidence of intent, that intent must govern, regardless of what a literal interpretation of the description (or the most nearly literal interpretation possible) might indicate. But as there had been no survey made and the commissioners had never seen the lake, there can be no "intent" as to any one particular point, and the question must be decided judicially from the text of the description only.

Under these conditions our view would be that the point marked B must be regarded as the northwest point, and not the point marked A, for the following reasons:

1. In a lake of approximately quadrilateral form like this (if not in all lakes), if there be any point which can be called the "northwest" point, there must be a "northeast," "southeast" and "southwest" point. Now, surely the point A must be regarded as the "northeast," the point C as the "southeast," and the point D as the "southwest" point, leaving point B as the only possible "northwest" point.

2. Again, the major axis of the lake runs approximately through the outlet and inlet points. If this axis lay exactly north and south, there would be no doubt as to which was the "northwest" point; it would be A. If this axis lay exactly east and west, there would again be no ambiguity as to which was the "northwest" point; it would be B. As the axis lies between these two directions, the only question is, Which of the two directions does the actual axis most nearly approach? and it is evident at once to the eye that it approaches most nearly to an east and west line, its bearing being about N. 52° W. Therefore, for the purpose of interpreting the point in question, it must be regarded as lying east and west, and not north and south, which makes point B the "northwest" point.

3. Again, if there can be assumed to have been any intent in the minds of the commissioners, it must have been that the meander line from D "the most southerly end of" the lake, to the "northwest point" should go more than half way round. The point D is clearly "the most southerly end," but A is as clearly the most northerly end. What was the intent of the commissioners in specifying the "northwest point" instead of the "most northerly point," which latter would seem to be the natural antithesis to the phrase "most southerly point?" Was it not that the meander boundary line should be carried half way around the lake and something more? It seems to us clearly so; and if we are thus carried on past the point A, we can only stop at the point B.

Map of Quinaielt Lake.

4. Again, assume that, despite the lack of a survey, the commissioners or some of their advisers had some vague notion of the form of the lake. The point D must surely have been in the mind of any one with such knowledge as the "most southerly point," and if anyone be standing there with a compass (or star) to indicate the north and south line, which would appear to him to be the "northwest point?" Clearly the point B and that only, for the point A is almost as far to the east as the point B to the west of north.

For all these reasons we should regard the point B as "the northwest point." We have given our reasons fully, as the question is one of great importance, to a few settlers at least. And we may add that, to avoid any possible prejudice in favor of either party in interest, we form and wrote down reasons 1 and 2 above before reading any more of our correspondent's letter than the first paragraph thereof. Full perusal of the letter only added reasons 3 and 4 to the list, and removed the doubt which we at first felt, whether there might not be clear indications of intent in parts of the treaty not before us, which would fix the "northwest point" independently of the map.—Ed.]

THE COMPRESSIVE STRENGTH OF BRICK.

Sir: In your issue of the 25th inst., under caption of "The Compressive strength of Brick," you take occasion to speak of a brick made by the National Brick & Tile Co., of Bradford, Pa., as having shown a crushing strength of 11,130 lbs. to the sq. in. You also note in same article test made by Prof. R. C. Carpenter, Cornell University, of an Ithaca brick made on an "angle" machine which showed a crushing strength of 14,900 lbs. to the sq. in., and add: "Prof. Carpenter believes this to be the highest of any brick on record." With all due deference to Prof. Carpenter's belief, I think, nevertheless, he is very much mistaken. Last August we sent samples of our vitrified paving brick, made from what is generally known as West Virginia fire clay, to F. A. Dunham, C. E., Dunkirk, N.Y., who had two of them tested at the Stevens Institute of Technology, Hoboken, N. J. Brick "A" showed a crushing strength of 15,720 lbs. to the sq. in., while brick "B" went to pieces under a load of 19,400 lbs. to the sq. in. This was made under date of Aug. 20, 1891.

About six weeks prior to this date (I do not have exact date by me), Mr. Dunham had another of our brick tested at same place, and it failed under a pressure of 19,090 lbs. to the sq. in. These tests were made, I believe, by taking from each sample a solid cube and dressing it down until its four sides were each exactly 1 in. square. Again, under date of May 1, 1890, we had two of our bricks tested as to crushing strength by Messrs. Hunt & Clapp, of Pittsburg Testing Laboratory, 95 and 97 Fifth Ave., Pittsburg, Pa., which showed a crushing strength for brick No. 1 of 24,810 lbs. to the sq. in. and for brick No. 2 21,820 lbs. to the sq. in. This test was made by using whole bricks placed on their edge and subjected to the test of a Keystone Bridge machine.

To the best of our knowledge, all these tests were carefully made and can, no doubt, be verified by both Mr. Dunham and Messrs. Hunt & Clapp. I might add, all these brick were made on what is known as a "stiff mud" machine, were burned to vitrifaction for street paving and, as a matter of fact, are just such brick as we furnished the city of Philadelphia this season for that purpose, and, unlike the Ithaca brick spoken of by Prof. Carpenter, did not have the advantage of being repressed before burning. Yours truly. A. L. Hull,

Secy. The American Fire Clay Co.

Toronto, O., Dec. 28, 1891.

ANCHORING BOLTS IN STONE.

Sir: For some years past I have invariably used Portland cement for above purpose. In using 1¼-in. bolt I have the hole drilled with a 2 in. drill and the bolt ragged. I have used this style of anchor bolt for the heaviest class of work—engine beds, turbines, pulp grinders and heavy bearings. Some years ago, owing to lack of experience in pouring sulphur at the proper temperature, I made a failure and then tried the cement with success. I have no hesitation in saying that in every respect good Portland cement is the best material I know of for anchoring bolts in masonry. Yours respectfully, M. J. Butler,

M. Am. Soc. C. E.

Napanee, Ont., Dec. 27, 1891.

The navies of Europe, according to the report of the French Naval Budget for 1892, stand as follows:

	Ironclads.		Cruisers.		Sloops, &c.		Total.	
	Old.	New.	Old.	New.	Old.	New.	Old.	New.
England	48	30	47	106	27	52	122	192
France	14	45	32	26	54	14	100	85
Italy	15	10	15	16	19	25	49	51
Germany	22	16	20	13	5	10	47	39
Russia	31	19	15	10	..	5	46	34
Austria	11	7	10	3	8	9	29	19
Total	141	127	139	168	113	115	393	410

The smaller crafts stand as follows:

	Gunboats.		Torpedo boats.	Total.
	Old.	New.		
England	55	8	171	234
France	43	..	190	233
Italy	20	..	139	159
Germany	8	..	156	164
Russia	10	4	142	156
Austria	5	..	65	70
Total	141	12	863	1,016

MILD STEELS FOR STRUCTURAL PURPOSES.

Abstracted by Gus C. Henning, M. E., from a paper by Friedr. Bischoff, for "Stahl und Eisen" for Sept., 1891,

I. BASIC STEELS IN AUSTRIA.

In July, 1887, the Austrian Government requested the Austrian Society of Engineers and Architects to give an opinion as to whether iron or steel should be used for the bridge over the Danube at Czernavoda (described in "Engineering News" of Aug. 23, 1890), the Roumanian Government having presented an inquiry regarding the matter. In reply the use of wrought iron was recommended, but the deliberations of the committee demonstrated that very little was known in Austria as to the behavior of mild steels.

This led to the appointment by the Society on Nov. 12, 1887, of a larger committee for the purpose of thoroughly investigating the behavior of mild steels. The committee was made up of 5 constructing engineers, 2 professors of the Technical School of Vienna, 2 representatives of bridge works, and 2 metallurgists, to which were added later a professor of the Technical School of Bruenn and the general manager of the Austrian Metallurgical Co.

Besides collecting information and opinions from many sources, the committee made 216 tests on specimens of wrought iron, Thomas steel (mild steel made in the Bessemer converter with a basic lining), and Martin steel (mild steel made in the basic open-hearth furnace), and these demonstrated that the Martin steel was by all odds the best and most reliable metal, being especially superior in point of toughness and resistance to distortion or injury in working. It was deemed advisable, however, to further test these materials by building full size girders and subjecting them to a breaking load.

For this purpose the Prague Industrial Works provided Thomas steel for one girder and basic Martin steel for another; the Austrian Metallurgical Works and the Witkowitz works each furnished Styrian wrought iron for one girder and basic Martin steel for another. The bridge works of Ig. Gridl, at Vienna, agreed to build these girders and the testing machine and make the tests free of cost. The girders were 32 ft. 10 ins. between bearings and 3 ft. 11 ins. deep over the chords. The rivet holes were punched and then reamed 0.078 in. larger. The riveting was done partly by a hydraulic machine and partly by hand. The pieces used in making the girder were cut from the stock with shears. The girders had a double system of diagonals and verticals. The chords were T shaped, consisting of a web 10 × ⅜ ins., and two angles, 2¾ × 2¾ × ⅜ ins. with a cover plate 6½ × ⅝ ins. The tension members of the diagonals were bars 3½ × ⅝ ins.; the compression members were two angles 2½ × 2½ × ⅝ ins., lying side by side and being riveted on one side to the tension members. The verticals were two angles 2½ × 2½ × ⅝ ins.

The new plate girders were 32 ft. 10 ins. c. to c. of bearings, and 2 ft. 7½ ins. deep, with a $\frac{7}{16}$-in. web. The chords consisted of two angles 2¾ × 2¾ × ⅝ ins., with two cover plates 6½ × ⅜ ins., and 18 ft. and 4½ ft. long respectively. Stiffeners were placed every 4 ft.

The old plate girders had a depth of 1 ft. 7¾ ins. and a $\frac{3}{16}$-in. web. The chords consisted of two angles 2½ × 2½ × $\frac{9}{16}$ ins., with three covers 8½ × $\frac{9}{16}$ ins.

To make the tests, two girders made of the same material were fastened together by a diagonal system of bracing connecting their top chords, while their bottom chords were joined by angles 2¼ × 2¼ × ⅝ ins. at each panel point.

This gave the girders such lateral strength as they would have in a completed structure; and they were then tested by applying a load at the center, measuring its intensity by a system of scale levers under one of the bearings of the girder. The load was gradually applied and the deflections were noted at regular intervals up to the point of rupture.

In these tests the basic Martin steel showed very satisfactory results; but the behavior of the Thomas steel was unsatisfactory. The Styrian wrought iron girders showed a strength far below expectation.

The committee made comparative tests to determine whether riveting together the web members of the girder at their intersection increased their resistance to buckling; and they conclusively proved that such an increase of strength did take place. Tests were made on Martin steel girders made in different ways, on a girder of Bohemian merchant iron to determine its strength compared with that of more expensive materials, and on iron plate girders taken from an old railway bridge. In this last test, the girders showed a very good strength; but the fact that they were only in use for a short time and were out of use for many years, blocks any conclusions as to the safety of old iron bridges. The girders of the inferior Bohemian wrought iron showed a high strength but were low in resilience. Subsequently pieces cut from these various girders were subjected to chemical and physical tests.

The conclusions reached from the whole series of experiments was as follows:

Thomas Steel.—Although the Thomas metal was found to have fair strength and elasticity, it was nevertheless demonstrated by the tests that it was exceedingly difficult to produce material of a uniform composition and that the metal was extremely sensitive to rough treatment. The poor results appeared to be due to a lack of homogeneity in the material; but this may have been due to the use of improper methods of fabrication. At any rate, confidence in this material for structural purposes, when worked according to practice prevalent in Austria, has been considerably shaken. The superiority of Martin steel and wrought-iron precludes the necessity of using Thomas steel for structural purposes; and immediately on learning the results of the tests, the Austrian producers of Thomas steel ceased attempts to introduce the metal for structural purposes.*

Wrought Iron.—The results obtained in the full size girder tests were good, though the Styrian metal proved much superior to the Bohemian. The resilience and elasticity, however, were found decidedly inferior to the Martin steel.

Basic Open-Hearth Martin Steel.—The tests showed this material to be eminently satisfactory for plate and lattice girders, rivets and riveted structures, especially when used under ordinary shop methods. It is greatly superior to wrought iron in its uniformity with regard to the direction of rolling, and in its reliability and freedom from injury due to rough usage or handling. While the

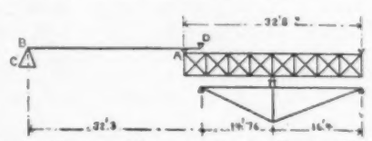


Fig. 1. Diagram of Apparatus Used in Testing Girders.

quality and methods of workmanship has an undoubted influence on the strength of built members of the material, no injurious effects could be traced to cold working or riveting. The composition of the Martin steel used in these tests was: C. .0101%, Mn. 0.34%, P. 0.048%, S. 0.035%, Si. 0.024%, Cu. 0.080%. Its average tenacity was 56,600 lbs. per sq. in., and the average elongation in 8 ins. was 25%.

The committee's formal report states that low carbon basic Martin steel is perfectly suited to structural purposes. The material used in any structure should be of one grade only, having a minimum tenacity of 49,800 lbs. per sq. in., with an elongation of not less than 25% in 8 ins. and a maximum tenacity of 64,000 lbs., with an elongation of not less than 20% in 8 ins. It must show proper ductility, both hot and cold, and indifference to surface injury of the test pieces. Such material may be worked like wrought iron; but either metal is better drilled than punched. If punched, however, all holes should be reamed by a correctly guided tool at least .078 in. Annealing this material before or after fabrication is not necessary. Rivets may well be made of this material.

Prof. J. E. Brick, of Bruenn, presented an appendix to this report, containing the following matter of interest: The investigations showed that the maximum percentages of different elements allowable in good basic Martin steel are as follows: C. 0.16, Mn. 0.40, P. 0.07, S. 0.04, Cu. 0.10, Si. 0.03. An increased percentage of carbon seems to diminish the influence of the other elements on tenacity and elasticity.

While the tests have shown that special precautions in working steel are no more necessary than in working iron, they have also shown most distinctly that the best shop practice, such as drilling instead of punching and power riveting instead of hand work, increases very considerably the resistance of structures, and especially increases their elasticity and resilience. Such superior methods of construction may even counteract non-homogeneity in chemical composition and non-uniformity of physical properties. Hence the best guarantee of the safety of a correctly designed iron or steel structure is good workmanship.

The quality which determines the life of material and structures is resilience, as determined by the elastic limit and resistance to bending. Soft basic Martin steel exceeds wrought iron so materially in this respect that a higher working load can safely be adopted.

Plate girders must be given lateral stiffness by the use of vertical angle stiffeners. Cover plates must be carried beyond these stiffeners, and the transverse stiffeners should be attached to their outer edge.

The law of proportionality of load and elastic deflection holds good almost to the point of rupture. Permanent deflection does not effect elasticity. Elastic resistances therefore remain constant up to time of rupture.

A description of these tests has also been furnished to us by Mr. W. G. Triest, Jun. Am. Soc. C. E., translated from the "Zeitschrift des Oesterreichischen Ingenieur und Architekten Verein," from which we select the following additional particulars:

In the work on test specimens which preceded the breaking of the full-size girders, both the Thomas and the Martin steel proved tough so long as the surfaces remained uninjured. Injuries to the surface, as well as the punching of holes, diminished the power to resist deformation with all the materials examined. Both kinds of steel showed about the same tensile strength and elongation, and seemed to be nearly or quite as strong at right angles to the direction of rolling as parallel with it. Thomas steel of uniform quality offered great resistance to bending so long as its surface was uninjured; but when the piece was nicked at the point of flexure, it would rupture suddenly, with a fine granular fracture over nearly the whole of the separated surface. The Martin steel when nicked withstood sharper bending, and finally broke like wrought iron, a part of the section hanging together, and the fracture showing often a fine silky fiber. Whether the bending was parallel or perpendicular to the direction of rolling the plate seemed to make little difference with Thomas or Martin steel. Punched holes unreamed and sheared edges unplaned seemed to have as deleterious effect as external injury to the piece in wrought iron as well as in steel. Both kinds of steel excelled wrought iron in uniformity of behavior. The following table gives the average results obtained in 216 tests of the several materials:

Material.	Parallel with direction of rolling. Tens. strength. Lbs. per sq. in.	Parallel with direction of rolling. Elongation. % in 8 ins.	Perpendicular to direction of rolling. Tens. strength. Lbs. per sq. in.	Perpendicular to direction of rolling. Elongation. % in 8 ins.
Wrought iron.....	50,500 to 54,200	20.4 to 27.0	36,300 to 49,100	2.96 to 11.3
Wrought iron plates.....	47,500	27.5	48,000	9.2
Wr'ght iron bars.	50,700	24.4	60,800	22.9
Thomas steel. Univ. Mill.....	55,700	30.6	56,900	22.4
Thomas steel. plates.....	55,400	30.1	54 700	28.7
Martin steel, C = 0.10%.....	47,100	29.6	48,500	30.1
Martin steel, C = 0.11%.....	47,900	30.6	47,100	29.0
Martin steel, C = 0.14%.....	51,000	27.5	51,100	31.1
Martin steel, Universal Mill	58,400	28.0	60,200	16.3
Martin steel, plates.....	61,100	26.0	59,700	22.8

These results proved the superiority of soft basic Martin steel. Its process of manufacture has, moreover, the great advantage of being slow enough to permit taking samples and modifying the furnace charge accordingly, so as to insure a uniform product of the required properties. With the Thomas process, on the other hand, the working is so rapid

* It must not be lost sight of, however, that according to tests to begin later the experience is quite different in Germany, where Thomas steel is regularly made which is claimed to be fully as good as Martin steel. This was indeed proved by Inspector Mehrtens after a most complete and exhaustive investigation.

that the composition of the material cannot be accurately ascertained.

The tests of full size girders, which were carried out as described above, were made with a hydraulic testing apparatus, illustrated in the accompanying diagram (Fig 1.) A load C, suspended from the end B of the unequal lever BD, produces at A a certain pressure which is counteracted at the middle of the girder by a hydraulic ram. To place the girder under a certain load, a weight corresponding to that load was placed at C, and the pressure on the hydraulic ram was increased until the lever CD was horizontal.

The first load applied was calculated to produce a strain of 5,690 lbs. per sq. in. in the two central panels of the chord; and each additional load increased this strain by 2,845 lbs. Each load remained for several minutes. Its effect was noted by measuring the vertical deflections of the girders and the bending out of the web members. The measurements were taken after each stage of loading. As soon as permanent deformation was noticed, the load was taken off entirely before it was increased. The stretch of several members was measured by a stretch indicator.

The behavior of the girders is well shown by the diagram given herewith, on which the elastic and permanant deflections are marked. The permanent deformation is produced by external forces overcoming the molecular resistance of the material and the resistance of the connections so far as to cause a permanent change of the original molecular composition and a relative shifting of the members of a connection. This resistance is a potential energy, limited and different for each material; it can be measured by the amount of work necessary to overcome it. Each permanent deformation causes a corresponding loss of potential energy, until, by repeated losses, the latter is absorbed entirely and a fracture ensues. The curves of the permanent deflection will be found to rise almost straight and very steeply at first. Then they become convex to the vertical axis, until, after a certain well defined stage of loading, they deflect still more and rise very slowly. The points where the curving reaches a maximum are called "critical points," for after they are reached each successive loading causes a greater deflection than the preceding. The zero point of the test loads is raised above the zero point of the co-ordinates on account of the original strain and deflections which the weight of the girder produces.

DETAILS OF THE SEVERAL TESTS.

I. Lattice Girders of Thomas Steel.—At a tensile strain of 37,000 lbs. per sq. in. in the 4th panel, the web of the tension chord of one girder split with a loud report in one of the dangerous sections. These lie between the diagonals of the center panels and the center vertical. The diagonals being connected with the web by rivets, carry their strain to the intersection of the strain centers through the web. This produces between a vertical section of the strain center of the center post, and the nearest row of rivets of the diagonals, strains different from and larger than the normal panel strains. Simultaneously the web around the holes nearest to the center post cracked. At an increase of load the chord angles tore and the web tore through the rivet holes of the center post. The other girder broke similarly. The fracture of the web was granular and unequal; the angles showed a fine, uniform texture, and were strongly contracted. Test pieces gave results as follows:

Location of test piece:	E.	Limit of elasticity. Lbs. per sq. in.	Tensile strength.	Elongation % in 8 ins.
Web of tension chord, 1st panel	28,150,000	24,400	58,300	25.5
Web at point of fracture	28,800,000	30,200	59,000	17.35
Chord angle of tension chord, 1st panel	27,700,000	25,000	50,100	32.1
Chord angle at fracture	28,300,000	33,700	55,450	29

The ratio of breaking strength to tensile strength of material was only 75 %.

This unfavorable result is mainly due to the unequal strength of the components of the chords; this resulted in the overstraining of one of its parts.

II. Lattice Girders of Martin Steel.—The tension chord of one girder tore apart in one of the center panels at a strain of between 46,200 and 49,100 lbs. per sq. in. The angles and web show contraction. The rivet holes were considerably elongated in the direction of the strain. The test pieces gave the following results:

Location of test piece:	E.	Limit of elastic'y. Lbs. per sq. in.	Tensile st'ngth.	Elongation % in ins.
Web of tension chord; 1st panel	29,150,000	25,300	56,600	22.9
Web at fracture	29,600,000	34.000	57,800	22.9
Angle of tension chord; 1st panel	30,190,000	35,400	63,500	28.1
Angle of tension chord at fracture	30,050,000	35,700	63,909	27.1

III. Lattice Girders of Styrian Wrought Iron.—The tension chord of one girder tore at a strain of 39,200 lbs. per sq. in. in the center panels. Fracture was fibrous, partly scaly and deeply contracted. Test pieces gave the following:

Location of test piece:	E.	Limit of elastic'y. Lbs. per sq. in.	Tensile st'ngth.	Elongation % in 8 ins.
Web of tension chord; 1st panel	29,900,000	23,250	59,500	17.1
Web of tension chord at fracture	28,150,000	33,800	57,900	20.4
Angle of tension chord; 1st panel	29,150,000	20,800	60,900	27.8
Angle of tension chord at fracture	28,850,000	26,800	64,700	23.5

IV. Lattice Girders of Martin Steel.—Fracture ensued at a tension of 51,200 lbs. per sq. in. Web was much contracted and uniform texture. Angles showed granular fracture and no contractions. Tests resulted as follows:

Locat'n of test piece:	E.	Limit of elasticity. Lbs. per sq. in.	Tensile strength.	Elongation % in 8 ins.
Web of tension chord, 1st panel	28,500,000	30,150	61,800	25.8
Web of tension chord at fracture	29,350,000	36,500	65,100	28.6
Angle of tension chord, 1st panel	30,150,000	26,000	70,000	28.6
Angle of tension chord at fracture	29,350,000	39,500	69,500	24

V. Lattice Girders of Martin Steel.—The fracture is much contracted, and shows a fine fibrous texture. Results of tests were as follows:

Location of test piece:	E.	Limit of elasticity. Lbs. per sq. in.	Tensile strength.	Elongation % in 8 ins.
Web of tension chord, 1st panel	28,750,000	33,400	54,300	29
Web of tension chord, at fracture	28,150,000	34,700	55,500	26.4
Angle of tension chord, 1st panel	28,900,000	30,300	58,000	28
Angle of tension chord at fracture	28,900,000	30,300	56,300	30.1

VI. Lattice Girder of Martin Steel. Less Careful Workmanship.—Fracture is much contracted, uniform, and finely fibrous. Results of tests were as follows:

Location of test piece:	E.	Limit of elasticity. Lbs. per sq. in.	Tensile strength.	Elongation % in 8 ins.
Web of tension chord, 1st panel	28,900,000	29,200	55,100	31.5
Web of tension chord at fracture	28,900,000	24,600	58,500	32.5
Angle of tension chord, 1st panel	30,200,000	25,000	51,500	21.7
Angle of tension chord at fracture	27,750,000	20,800	56,500	27.1

The ratio of breaking strength to the tensile strength of material is 83%.

VII. Lattice Girders of Martin Steel, Careful Shop Work.—Location and appearance of fracture same as in preceding experiment. Tests as follows:

Location of test piece:	E.	Limit of elasticity. Lbs. per sq. in.	Tensile strength.	Elongation % in 8 ins.
Web of tension chord, 1st panel	28,900,00	28,000	52,800	10
Web of tension chord, at fracture	32,000,000	21,200	62,300	27.1
Angle of tension chord, 1st panel	31,800,000	23,700	54,750	32.9
Angle of tension chord at fracture	32,800,000	20,650	54,150	30.5

The ratio of breaking strength to tensile strength of material is here 97%. It is a fact specially worthy of note that these girders stood so well in spite of the inequality of material. With reference to the more uniform and consequently better material of Test VI. rolled at the same mills, it becomes evident that the superiority of workmanship not only increased the strength of the construction but even made up for the deficiencies of the material.

VIII. Lattice Girder of Bohemian Wrought Iron.—The fracture is short, fibrous, partly scaly, shows very slight contractions. Results of tests are:

Location of test piece:	E.	Limit of Elasticity. Lbs. per sq. in.	Tensile strength.	Elongat'n. % in 8 ins.
Web of tension chord, 1st panel	29,200,000	25,300	47,500	8.15
Web of tension chord, at fracture	30,300,000	28,600	53,500	8.15
Angle of tension chord, 1st panel	28,900,000	25,800	51,800	19.65
Angle of tension chord, at fracture	28,900,000	25,300	50,670	10.6

IX. Plate Girders, Martin Steel.—After the strain of the dangerous section exceeded 43,400 lbs. per sq. in., the compression chords of both girders began to bend outward. When the strain had reached about 46,300 lbs., the chords bent gradually but completely, without fracture however. The extent of the bending was limited to the part of the chords between centers of girders and the nearest vertical stiffeners. The greatest deformation showed at the ends of the outer cover plates, opposite the dangerous section. These cover plates and chord angles were folded together as if they were made of lead, but there was not a trace of a rent anywhere. The web was bent out of its vertical plane. If the outer cover plates had been continued to the stiffeners, the girders would probably have proved more rigid. This test shows that with soft, tough material the resistance of the compression chords against bending must be increased by stiffening them laterally. Results of tests were:

Location of test piece.	E.	Limit of elasticity. Lbs. per sq. in.	Tensile strength.	Elongation % in 8 ins.
Web near point of bending	31,200,000	21,900	59,800	13.8
Outer cover plate near bending	31,650,000	26,400	57,800	24.25
Chord angle near bending	28,900,000	22,800	51,100	35.25

X. Old Plate Girders of Wrought Iron.—These girders had been in use for a year, and had been stored away for 14 years. The shop-work had probably not been very good, as the girder had been built for temporary use only. One of the girders broke suddenly with a loud report at a strain of 43,400 lbs. per sq. in. The fracture was short, fibrous and showed the material to be somewhat defective in homogeneity, the separate piles not being perfectly welded together.

Beside the important conclusions from these experiments which have already been noted, it was shown that small surface defects in the test girders had no effect upon their strength; also that it is highly important that all parts of a member shall be made of material of uniform strength. Otherwise the weakest material will give way before the strongest has received its full load.

THE CITY OF LONDON AND ITS TRAFFIC.

The report which follows, taken from an abstract in the London "Railway News," supplements in some important points the report of Mr. Osborne Howe, previously printed, on rapid transit methods abroad:

The report of the Local Government and Taxation Committee of the London Corporation, just published, with the results of the day census of 1891, gives striking evidence of the enormous magnitude of the traffic to and from the city, or business portion, of London. The population of the city, according to the imperial census, is only 37,694, while the mercantile and commercial population, as ascertained by the day census, is 301,384, made up of 29,520 employers, 202,213 male employés, 50,416 female, and 19,235 children under 15 years of age.

The number of passengers on foot and in vehicles entering the city on May 4 last, was 1,186,094. Of these 1,100,636 entered in the 16 hours (day), 5 A. M. to 9 P. M., and 85,458 in the 8 hours (night), 9 P. M. to 5 A. M. The total number of vehicles was 92,372, of which 85,826 entered by day and 6,546 by night. This total of vehicles was made up of 18,020 cabs, 10,389 omnibuses, 42,366 other four-wheeled vehicles, and 21,597 other two-wheeled vehicles. From 5 to 6 A. M. the total passengers passing into the city was 14,094, from 6 to 7 it was 27,289, and from 7 to 8 57,219. Thence it leaps up with a bound to 132,835 from 8 to 9, falling a little—to 124,942—from 9 to 10. Afterward, up till 8 o'clock in the evening, it maintains a fairly steady influx of from sixty to eighty thousand. Naturally it falls greatly during the night, at no time between 12 and 4 A. M. being so many as 3,000 per hour. In fact, from 2 to 3 there were only 656 persons passing in. The vehicular traffic exhibits much the same features, though its contrasts are not so great. From 5 to 9 the traffic increases regularly from about 1,000 to 5,000 per hour. After that time it remains until 6 o'clock in the evening very consistently at about 7,000 per hour, the three exceptions being from 10 to 11 A. M., when it rises to 7,860, and from 1 to 2 P. M., when it falls to 5,603, and 2 to 3, when it is only 6,241. So far as the inlets to the city are concerned, London Bridge is by far the most used. The total number of passengers crossing it citywards in the 24 hours is 167,421, and of vehicles the number is 14,367. Holborn Bars is, or are, next, 82,367 passengers and 9,069 vehi-

cles passing them. Temple Bar is close by with 81,672 passengers and 6,172 vehicles. Of the railway stations Liverpool Street is first with 52,413 passengers and Broad Street next with 43,917. In the ten years, 1881-91, the number of passengers entering the city each day has increased by 388,531 and the number of vehicles 20,479.

The number of passengers entering the city from the various railway stations in the 24 hours is returned at 266,415, as compared with 176,009 in the 1881 returns. It should be stated, however, that the 1891 figures include six more stations than the 1881 returns, viz., the electric railway at King William St., St. Paul's station of the London, Chatham & Dover, the Cannon St., Monument and Mark Lane on the City Lines Extension of the Metropolitan District Co., and Aldgate on the Metropolitan. The St. Paul's station has, to a large extent, relieved the traffic at Ludgate Hill, and in comparing the figures of the London, Chatham & Dover it is better, therefore, to take the total of the four, viz., Snow Hill, Holborn Viaduct, Ludgate Hill and St. Paul's. It will be seen that the total of these four stations was nearly 32,000, against 24,000 in 1881, Ludgate Hill having been relieved to the extent of 2,000 passengers per day, most of whom have gone to St. Paul's to their own and the company's advantage. In the same way the arrivals at the Mansion House station of the District Co. are about 5,000 a day lower, but then the Cannon St., Monument and Mark Lane stations have now a record of nearly 12,000 passengers a day, which includes those who previously alighted at the Mansion House before the inner circle was completed. In the subjoined table the returns of the District Co. have been grouped as they practically form one large station, and in the same way the figures of the Aldgate, Bishopsgate, Aldersgate and Moorgate stations of the Metropolitan are included in one total. Liverpool St., it will be noticed, still heads the list with 52,000 passengers in the 24 hours; Broad St. following with 44,000 and the London, Chatham & Dover group of four ranking third with 32,000, and Cannon St. and Fenchurch St. coming fourth with 27,000 each—there was, in fact, only 17 passengers difference between the two totals. These and other figures of the returns refer, of course, only to the entries into the city—the bulk of these passengers by rail are also taken back at night by the railway companies. The following are the returns for each of the companies of the number of passengers entering the city through their stations situated within the city boundaries:

	Day (16 hours.)		Night (8 hrs.)		24 hours.	
	1891.	1881.	1891.	1881.	1891.	1881.
Broad street (N. L.)	42,215	29,506	1,782	938	43,913	30,444
Cannon St. (S.)	26,524	20,471	727	655	27,252	21,126
Fenchurch St. (L. T. & S. E.)	26,729	15,242	540	441	27,269	15,683
Ludgate Hill (L. C. D.)	15,772	18,350	961	566	16,733	18,916
Snow Hill (L. C. D.)	2,808	2,532	164	84	2,972	2,616
St. Paul's (L. C. D.)	7,244	.....	61	...	7,305	.....
Holborn V. (L. C. D.)	3,680	2,777	1,026	75	4,706	2,852
Electric Railway	3,935		1,853	.....	5,789	.....
Liverpool St. (G. E.)	49,855	32,324	2,587	1,566	52,413	33,890
Metrop. District	25,836	17,069	801	1,246	26,637	18,315
Metropolitan	47,722	29,718	3,740	2,409	51,422	32,127

BREAKING GROUND FOR THE NEW YORK AND NEW JERSEY BRIDGE.

On Thursday morning last, Dec. 24, the New York & New Jersey Bridge Co. (which should not be confounded with the North River Bridge Co., of which Mr. Gustav Lindenthal is Chief Engineer) went through the ceremony of turning the first sod for its proposed structure. We learn, on application, that the company has not yet decided upon the plans to be adopted for the structure whose construction has been thus begun, but doubtless these will be forthcoming before Congress grants authority for the construction of the bridge.

The circumstances attending the ceremony of turning the first sod were somewhat inauspicious. There was a pouring rainstorm and the five hackloads of officers and guests who came from New York failed to meet a similar party from the New Jersey side, who had been notified simply that "the point where ground will be broken is on the Bergen Line

Some idea of the vastness of the number of persons daily entering the city can be formed from the fact mentioned in the report that if they were to be dispatched from any given station, 1,977 trains, each conveying 600 persons, would be required for the purpose. Supposing that the starting point were Euston, and the engine of each train touched the guard's van in the rear of the one immediately preceding it, the unbroken line of trains would extend to a distance of 221 miles. Taking the number of passengers entering the city on May 4, and computing that about a like number left it, we arrive at this startling calculation -that if this inward and outward passenger traffic were sent out of London in the manner indicated above, the first train would have been to Liverpool, a distance of 201 miles, and back again to Euston, to find upward of 214,000 persons struggling to get on the platform to start.

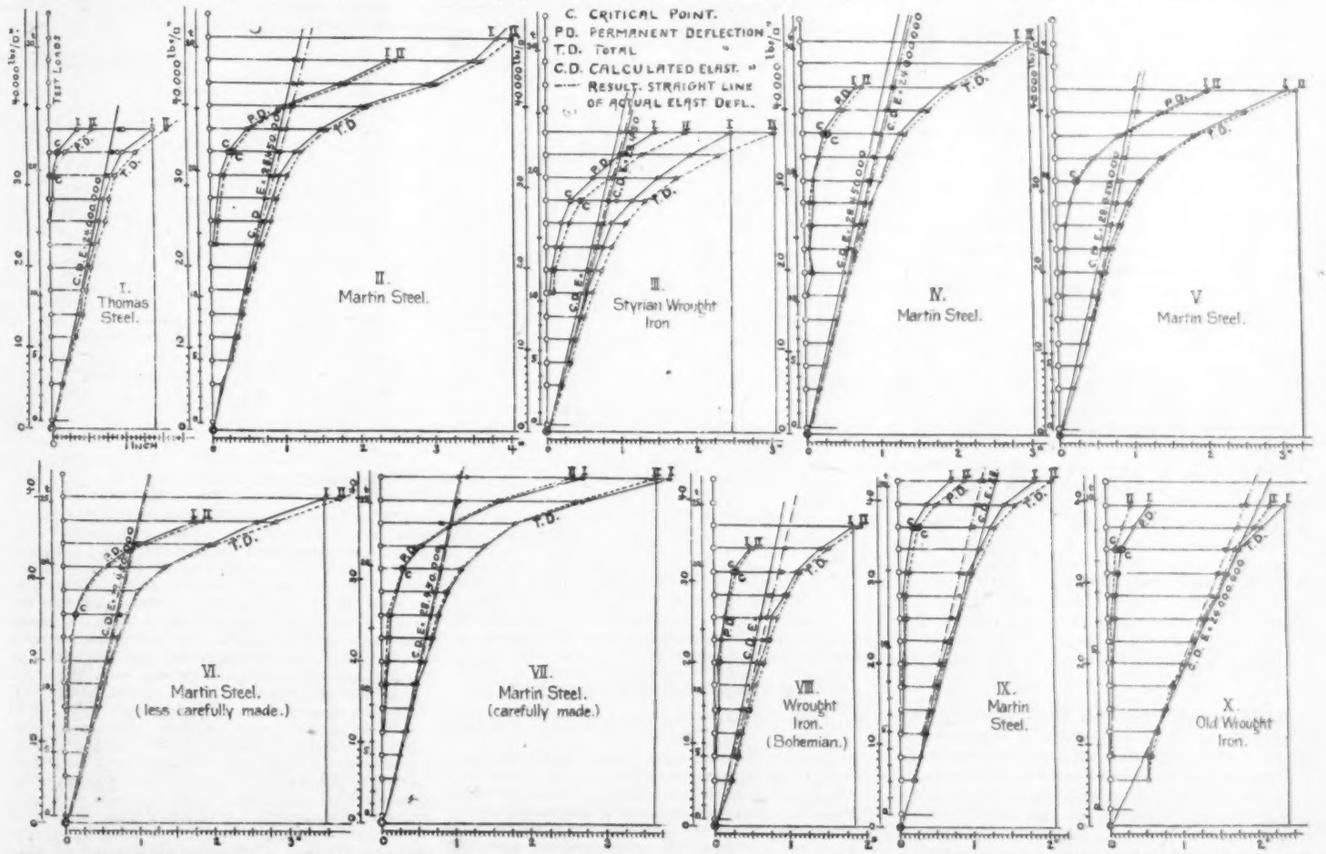


FIG. 2. TESTS OF FULL SIZE GIRDERS OF VARIOUS MATERIALS MADE BY A COMMITTEE OF THE AUSTRIAN SOCIETY OF ENGINEERS AND ARCHITECTS.

		Tensile strength of test bars, average.	Elongation of test bars, average.	Breaking strain.*	Ratio of breaking strength of girder to tensile strength of material.	Work of deformation of each half girder, in hundreds of inch-pounds.	
		Lbs. per sq. in.	% in 8 in.	Lbs. per sq. in.	%	Elastic.	Permanent.
‡ I.	Thomas steel	55,000	25.8	41,000	75	377	305
‡ II.	Martin steel	59,600	25.1	54,000	90	1,730	306
‡ III.	Styrian wrought iron	59,800	29.7	43,600	73	890	282
‡ IV.	Martin steel	66,200	26.6	55,600	84	972	688
‡ V.	Martin steel	55,100	28.2	49,300	89.7	1,185	361
‡ VI.†	Martin steel (less carefully made)	54,700	28.0	45,000	83	1,190	296
‡ VII.†	Martin steel (carefully made)	55,200	24.0	53,600	97	2,580	436
‡ VIII.	Bohemian wrought iron	50,000	11.6	45,000	90	423	247
§ IX.	Martin steel	55,200	21.4	45,500	....	328	265
§ X.	Old wrought iron	....	....	42,600	....	110	211

*In the column headed "Breaking strain," the upper figure gives for the lattice girders I. to VIII., the breaking strain in the central panels of the tension chord. The lower figure gives the breaking strain in the "dangerous section."

†In making girder VI. the rivet holes were punched, and reamed only what was absolutely necessary to insert the rivets. Riveting was mostly done by hand. In making girder VII. all rivet holes were drilled and the rivets driven by hydraulic power.

The ultimate strength of the less carefully and very carefully made girders of tests VI. and VII. has the ratio 1 : 1.21. Thus the latter girders were 21% stronger than those made with less care. The elastic deflections were nearly alike for both pairs; but the permanent deflections were always larger, and, with higher tensions, much larger, for the less carefully built girders.

‡ Lattice girders. § Plate girders.

Road, north of Weehawken and south of Guttenberg," a direction no more definite than if it had read "on Broadway, north of the Battery and south of Central Park." The project and the proposed inaugural ceremony had attracted so little attention from the residents in the vicinity that no one could direct to the desired spot the party which had gone astray. After visiting in vain several different points they gave up the search in despair.

The New York party drove to the site chosen for the pier, which is in a large rocky field. Here Mr. Andrew H. Green, Chairman of the Bridge Commission appointed by the New York Legislature, proceeded to the spot selected, escorted by Mr. Chas. B. Brush, Assistant Engineer, hurriedly turned over a sod, and then returned to his carriage. Those who saw the act, if the list published in the morning journals is correct, were Directors Chas. M. Vail; Evan Thomas and Jas. T. Sparkman; Geo. W. Greene, Counsel; Chas. H. Swan, Auditor; Thos. C. Clarke, Chief Engineer; Chas. B. Brush, Assistant Engineer, and Gen. H. A. Barnum.

The rain making it quite impossible to have any speechmaking on the ground, Assistant Engineer Brush invited the party to adjourn to the directors' room in the water tower of the Hackensack Water Co., about a mile distant, and the invitation was accepted. Chairman Green, after the party arrived at the water tower, made a speech, enlarging at some length on the importance of the bridge to the further development of New York City. Mr. E. Thomas, President of the Produce Exchange, congratulated the directors on the progress that had been made. General Barnum said he joined in the congratulation because he knew of many of the difficulties the directors had met in securing the necessary legislation. He wished the engineers having the construction in charge the same success Roebling had with the Brooklyn Bridge.

Chief Engineer Clarke said the question was often asked if the bridge would pay when built. To this he replied that if every passenger on the Pennsylvania Railroad had a trunk with him, the usual express charge of 40 cts. on each trunk would pay the fixed charges of the whole scheme.

What the passenger was to do with his trunk after he reached the New York terminus, was not stated. Charles H. Swan said a gang of men would begin work on Monday and that the work would be pushed as rapidly as possible. When the meeting adjourned it was to meet on Wednesday, Dec. 30, in 67th St., between 11th and 12th Aves, when the first soil was removed for the construction of the abutment at that place. Owing to having to anticipate our issue because of the occurrence of New Year's day, we are unable to include a report of the procedures at the New York pier in this issue.

A SAFETY STOP FOR M. C. B. DRAWBARS.

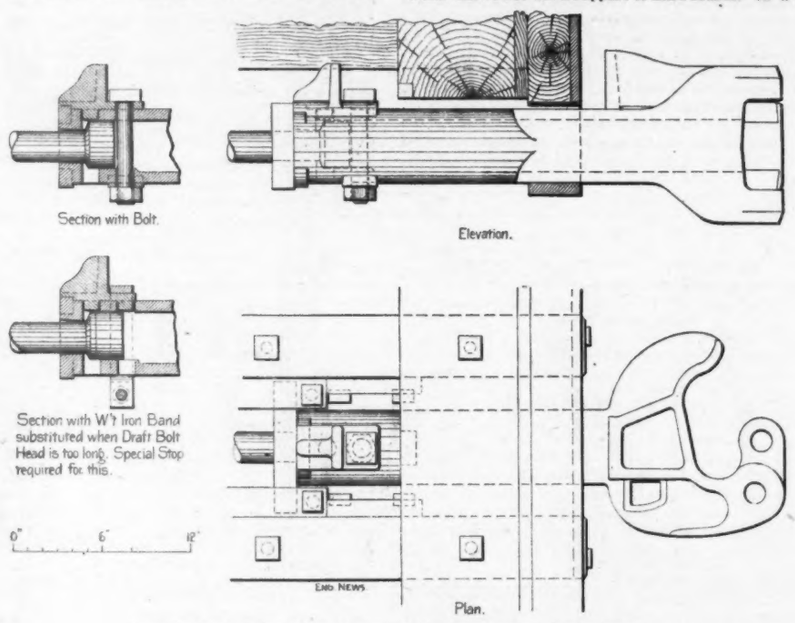
One of the objections which has been urged against the M. C. B. drawbar is the danger of derailing trains in case of the breakage of the draftbolt or the tail of the bar, permitting the drawbar to pull through the carrier-iron and drop upon the track. The head of the M. C. B. bar is so much larger than the common cast-iron drawhead, that it is much more likely to be hit by some part of the train and perhaps be knocked onto the rail. While this has hardly been a common or serious cause of accident, so far as we are informed, several derailments have been due to it, though it is an evil not very hard to cure.

In order to overcome it, the McConway & Torley Co., manufacturers of the Janney coupler, have brought out the safety stop for attachment to the tail of the M. C. B. drawbar, shown in the accompanying engraving. In case of the breakage of the draftbolt or of the tail end of the coupler, the safety stop comes against the end sill and the drawbar is held from pulling through the carrier-iron.

The engraving illustrates the application of this device to the M. C. B. draft gear. The safety stop is bolted to the top of the drawbar in front of the draft-bolt, and is held by a 1⅛-in. bolt passing through the bar. Where the draft-bolt head is so long as to interfere with the passage of the safety-stop bolt, a special stop is used, and is held in place by a wrought iron band encircling the bar.

The stop is also furnished, where desired, for use with the Graham draft-gear. It is in this case bolted to the under side of the drawbar by a hook-headed bolt, which does not interfere with the draft-bolt. When the drawbar is pulled forward, the safety stop hits a cast-iron striking plate, which is bolted to the end-sill just back of the carrier-iron.

It would be interesting to know what the ultimate resistance of a drawbar equipped with this safety stop would be, and we trust that experiments to determine it may be made. It may be questioned, whether greater security would not be had, on the whole, if an amount equal to the cost of the safety stop were expended in strengthening the draft-bolt and its connection to the tail of the drawbar. It is suggested that the use of the spring yoke to hold the tail of the bar instead of the draftbolt would prevent drawheads from pulling out, and we believe the spring yoke is largely used, especially in the West.


Section with Bolt.
Elevation.
Section with W't Iron Band substituted when Draft Bolt Head is too long. Special Stop required for this.
0" 6" 12"
END NEWS
Plan.

A SAFETY STOP FOR USE WITH THE JANNEY COUPLER.

The McConway & Torley Co. authorize us to state that this safety stop will be furnished free of charge to companies which have purchased the Janney freight coupler in sufficient numbers to equip al couplers now in service.

EARTHEN VS. MASONRY DAMS.*

By W. W. Follett, Asst. Eng. U. S. Dept. of Agriculture.

The subject given me for discussion is a misnomer There is no conflict between earthen and masonry dams. The two forms have each their place and are not interchangeable. There are also several other kinds which serve a useful purpose under certain conditions. In this paper I will confine myself to those problems which relate to irrigation work, and many statements made will need this limitation to render them true.

Dam sites met with in irrigation works may be roughly divided into two classes. 1. Those where the storm and flood waters must be passed over the crest of the dam. 2. Those where the storm and flood waters can be carried around the dam. The more common forms of dams are about as follows:

1. Brush or log and rock dams.
2. Crib dams.
3. Framed timber dams.
4. Masonry dams.
5. Earthen dams.
6. Loose rock dams.

Of these classes, the first four can be used in the first class of sites, i. e., where the water must be discharged over their crest. The last two are used where the water is carried around the dam. The first three classes are more properly used for diversion works, while the last three can be also used for reservoirs.

1° BRUSH DAMS.—In streams with shifting sandy bed where it is difficult to secure a good foundation, the old frontiersman's dam of brush and rock is very efficient where only a few feet—say not over eight or ten—of rise has to be made. Some of you may be inclined to scoff at this dam and say that it is not worthy of an engineer's attention, but you may all find occasion some time to use it. It can rest on any kind of foundation, but for a stream with quicksand bed it is probably the best known form of dam.

Willow brush is the best for this work and it adds to the strength of the dam to tie the willows in fascines of some 6 or 8 ins. in diameter. The upper slope may be made quite steep, but the down stream one should be concave and flat at the toe—even so flat as ten on one. The object is to so train the water as to have it leave the brush work in practically a horizontal direction.

Sometimes piles are first driven; then the brush and rock work built up around them and an overfall and apron of timber built on the piles on top of the brush. The object of this is to form a permanent crest on which frame work can be set for a support to flash boards. In a torrential stream it frequently happens that the floods are so great and the available waterway at the dam so small that it is not safe to have the permanent crest so high as needed to turn all the stream's flow at low water into the canal, hence flash boards or some movable gates are used to raise the crest in low water. While this gives the raison d'être for this form of construction, it does not seem to me a wise combination, as the brush and rock will inevitably settle, thus leaving a space between it and the timber above, causing a troublesome leak. The rough log and rock dam also serves a useful purpose in gravelly or bowlder sites where timber is plentiful.

2. CRIB DAMS.—Some engineers recommend crib dams for quicksand foundations—the cribs of heavy timber and filled with rock. Settlement will very likely be unequal and so tend to overthrow the dam—or get the cribs out of line if the dam is built of separate cribs, or tear the timbers apart if it is built as a single continuous crib—in either case threatening the integrity of the structure. The crib is frequently used in streams with gravel or rock bottom. It is a useful form here, many very creditable structures being made.

At Great Falls, Mont., is a crib dam on rock bottom at the Black Eagle Falls in the Missouri River. The dam is built to furnish power for smelting and manufacturing and is about 750 ft. long and 15 ft. high. It is built of a continuous crib drift bolted to the solid rock bottom, filled with rock and heavily decked with plank. The crest is protected with boiler iron. Both slopes are about one on one. This dam is a fair sample of what can be done with crib work and good sense. It is likely in this particular case that considerable of the river's flow is lost by leaking under the structure through crevices in the rock. Leakage is a weak point in a crib dam seated on solid rock. At Great Falls, however, the greater part of the probable loss is through deep vertical seams in the sand stone of the river's bed.

The crib is especially useful in damming a stream which has a rather large low water flow, as it can be built in sections and the gaps closed one at a time, gradually turning the water through the water gates with much less trouble than would arise from attempts to coffer dam against the main part of the river's flow. Only a small section of the site need be cleared at once to put in the mud sills bolted to the rock, while in a masonry structure a large portion of thebed must be exposed at one time. The flow of the Missouri at Great Falls was some 3,500 cu. ft. per sec.

*Read before the Denver Soc. of Civil Engineers, Dec. 8, 1891.

while the dam was being built, but it was handled with no great difficulty.

3. FRAMED TIMBER DAMS.—The third class, framed timber dams, may be used either on a rock bed or on a clay or gravelly clay foundation, the timber work in the latter case resting on piling. Framed timber may even be used on foundations consisting almost wholly of gravel only containing enough clay to impede the passage of water.

The cross-section most commonly used for a timber dam has a vertical front and a flat slope on the upstream side. The overfall is vertical, with the water falling on a heavy timber apron. The bit of level on top is not necessary except as giving a better chance to put in flash boards if they are used to raise the level of the water in time of minimum flow. The upstream face may slope about one on one. When resting on a clay or gravelly clay foundation a row of sheet piling carefully driven across the stream at the upstream toe lessens the danger of the dam being undermined. A backfilling of earth will serve a useful purpose as a tamping to close small leaks. This becomes a necessity when the dam rests on a gravelly foundation, and should be carried upstream some distance.

The weak point about the framed timber dam is the apron on which the water falls. Even for low falls—of 15 or 20 ft.—this should be of 12-in. timbers laid solid. Especially is this true in a stream where driftwood may come down on a flood. The apron should be carefully watched to see that its integrity is not impaired. I am told that the first dam at the head of the High Line canal—which was framed timber—was destroyed by the apron temporarily made light, being first broken up by a large number of crossties coming over the dam. This break was neglected, and after standing one or two small floods, even in its weakened condition, the dam finally went out. About one-half its length rested on solid rock, and the other half on a rock fill made under water as a spoil bank from the tunnel at that end of the dam. While the break started at about the point where the loose rock joined the ledge, it is likely that the failure occurred by the washing out of the loose rock. This instance is quoted to show the importance of first making the apron heavy and then watching it to see that no break occurs.

Where timber is cheap, the crib and framed dams are useful. Their first cost is low, and their life and service fairly good. They are objected to by some as being too temporary in their nature and not coming up to the standard of construction, which should be adopted for larger irrigation works. "The proof of the pudding is in the eating." Many elaborate schemes with solid masonry dams, costly iron viaducts and heavy masonry retaining walls and other works along the line of the canal have "died a bornin'," and many more become bankrupt and are abandoned before completion. On the other hand; nearly all of these conservative, carefully constructed head works and canals where all due attention is given to economy in first cost, which can be given without weakening the structure, are paying a handsome profit on their cost after deducting all expenses for maintenance.

The three forms of dam already described are useful only for diversion works—the first because it is but temporary at best, and the last two because timber enters largely into their composition, and in order that its life be reasonably long it must be constantly wet. This can occur in diversion works, and will occur unless the minimum flow of the stream is very small—but cannot occur in the storage dam.

4. MASONRY DAMS.—The masonry dam is useful both for diversion and storage works and can be used both where floodwater must pass over its crest and where it is carried around the structure. There is one safe proposition which can be laid down in the use of a masonry dam and that is: The dam must rest on solid rock. There are a good many instances, some of which you each can probably call to mind, where this is not done, but where masonry dams have been built resting on clay or on gravel. A masonry dam was once built in Spain which for a part of its length rested on piles. It is needless to say it failed completely and went out before the reservoir was filled to high water mark. A masonry dam is an absolutely rigid structure. The least unequal settlement tends to crack it and any appreciable settlement will rupture it. As soon as a crack occurs in a dam its integrity is threatened and, while it may not fail, its life is endangered. A clay foundation must yield under the weight imposed. If the load on the clay were uniform and constant the settlement might be equal and no disastrous rupture of the masonry occur; but, unfortunately, such is not the case: the pressure under the upstream toe may vary from almost nothing, when the reservoir is full, to three tons per square foot or possibly a little more, when the reservoir is empty, and this is an oscillation which occurs every time the reservoir is filled and emptied. So that, although the dam may be intact on completion and remain so after several fillings and emptyings of the reservoir, it is likely to fail at any time from this constantly changing pressure on the toe and so become a constant source of danger; not, except in a few cases where there are inhabitants immediately below it in a cañon, to life, but danger to the value of the industrial plant of which it forms a part.

There is another good reason why a masonry dam should not rest on clay. The safe load on the foundation of a masonry structure, so far as the masonry itself is concerned, is about ten to twelve tons to the square foot but clay will not carry this load nor half of it—so that the footing of the masonry dam must be inordinately spread, and much useless material put in to avoid overloading its foundation. The result is a structure which is not economical.

The fact that some few masonry dams have been set on clay, and have stood does not alter the truth nor pertinancy of these statements. The same remarks are applicable, with perhaps some minor restrictions, to gravel or bowlders foundations. In this class of sites there is an added danger. The water is almost sure to find some vent under the dam through the gravel and boulders, and will be likely to wash out cavities which will induce unequal pressure on the dam's foundation, and tend to settlement and rupture.

Another general proposition with regard to the use of masonry in dam construction may as well be stated now. It is not advisable to combine masonry with any other material—as loose rock or earth—in dam construction in such a way that dependence is placed on the two jointly to resist the pressure of the water. Of course, masonry has frequently to be used in earthen dams to protect the head of waste gates to form by washes, etc., but it is not wise construction, for instance, to put a masonry core in an earthen dam or a masonry shell or apron over loose rock. The masonry is rigid, the earth or loose rock flexible, and their combination is likely to be about as satisfactory as trying to mix oil and water.

No kind of dam has received so careful and intelligent study from engineers as that of masonry, and I will not attempt to discuss the proper form of cross section except to say that where the dam is not intended for an overfall the section evolved by the Quaker Dam Commission, or the modified form recommended by Wegmann in his "Design and Construction of Masonry Dams," is undoubtedly the best. In this form the curved surface is reduced to a small amount, the most of the exterior being laid on plain batter lines. Where used as an overfall the cross section adopted at Vyrnwy dam, near Liverpool, is probably the best. In this dam the down stream face is all curved and made to conform theoretically to the line of flow which the water going over it can be made to take with the least friction. The only serious objection to this is its cost, as the cross section resulting from the required curve of face is much in excess of that required for stability, and the curved face is rather difficult of construction, necessitating templates or many careful points given by instrumental work on the structure during its progress.

While safe to allow the water to fall sheer from a crest to bottom of the dam up to a certain height of fall, the character of the rock forming the base, the magnitude of the floods to be discharged and the strength of the rock used in the masonry must all be considered in determining what this height is. With a soft limestone or sandstone base only a low fall would be safe, while with granite as high as 30 or 40 ft. might be admissible. For greater heights than this the curved lower face is preferable.

Sometimes masonry dams are built with the down stream face stepped to break the force of the water's fall. It does not seem to me that this is as good construction as the curved face, as the dam is subjected to a constant jar, which must tend to disintegrate the cement and loosen the joints.

There is considerable controversy as to the form which should be given to the plan of a masonry dam. Some engineers claim that curving the dam upstream adds materially to its stability, while others maintain that no additional strength is thus derived, saying that in order that the dam act as an arch it must move, although the movement may be very slight. It is probable that this is another instance of that peculiar method of reasoning in which all dependence is placed on formulæ and none on common sense. The proposition that a straight dam is as strong as a curved one seems to me almost absurd. In the case of the straight dam any sudden shock—as the impact of a large body of driftwood or an earthquake shock—would tend to rupture it. The direction of movement would be in either case down stream. As soon as movement occurs tensile strain must begin on the down stream face—and masonry is not fitted to resist tension—so that rupture and failure are imminent. The same causes would be just as likely to move the curved dam, but as soon as the least movement occurred the arch action would begin, if not already existing, and the joints of both upper and lower faces, instead of having their stresses reversed, would have them increased. For this reason alone, if for no other, it seems best to make all masonry dams curved where the site is such as to render it possible without materially increasing the cost.

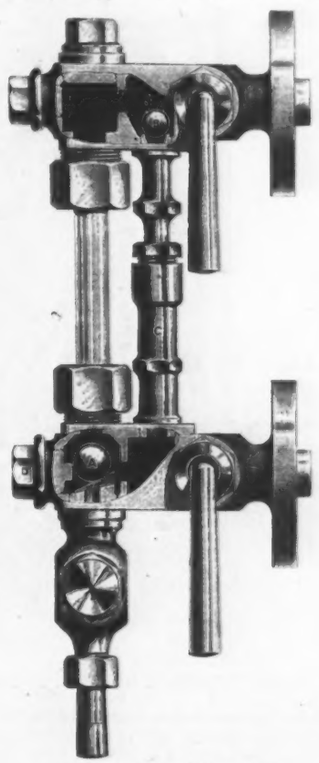
Owing to its porosity sandstone is a poor material for dam masonry, while limestone, granite or any hard close-grained rock, impervious or nearly so to water, are good. The kind of masonry used in the Vyrnwy dam is the best They there denominated it "Cyclopean Masonry." The largest stones possible are used, and their shape made irregular. The work is not carried up in courses, and especial care is used not to allow a joint to extend clear through the dam. Of course great care must be used to make the masonry absolutely solid and to bond the whole mass together.

[To be continued.]

A SAFETY WATER GAGE.

Quite a number of casualties have occurred of late through the breaking of water gage glasses, and it is noticeable that with the constant increase in working pressures of boilers such accidents are likely both to become more common and to be more serious when they do occur. Many devices have been invented to prevent the rush of boiling water and steam which ordinarily follows the breaking of a gage glass; but none of them has come into general use, partly on account of mechanical defects and partly, it is probable, because of general apathy concerning safety devices, even on the part of those whose lives are at stake.

The subject, however, is one which deserves careful attention, especially on the part of those who



Hopkinson Safety Water Gage.

fit up boilers for use in confined places, such as the stokeholds of vessels. We illustrate herewith from "Engineering" a safety water gage, which has been put on the market by J. Hopkinson & Co., of Huddersfield, England, and which seems to be a practical and efficient device, not likely to get out of order nor to close the opening from the boiler to the glass and thus lead to false indications. The device is described as follows by our contemporary:

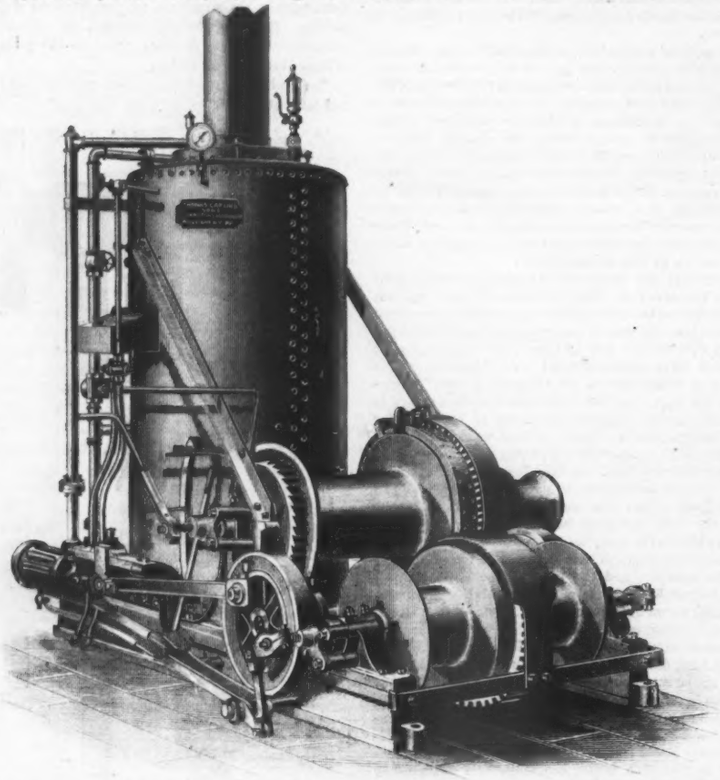
As will be seen, there is a valve both in the steam and in the water arm, and both these valves come to the seat in case of accident. The lower ball valve A is made so heavy that it cannot be held up against its seat by the pressure of the column of water in the boiler, and consequently there is no danger of the water being trapped in the glass and kept there to give a false indication. Further, the ball is of such a weight that it will not be carried up by the rolling of a vessel or the shaking of a locomotive. The ball B in the steam arm rests over the upper end of the supplemental tube C, as shown, except when it is forced forward against its seat, as shown in dotted lines. It also is safe from dislodgment by shaking.

When a glass breaks, the water pressure in the lower arm throws the valve A against its seat and stops all escape at the lower end of the glass. At the same time the rush of water up the supplemental tube C lifts the valve B. This is then forced against its seat by the steam, and thus all escape is cut off instantaneously and certainly. A new glass can then be fitted with safety. Upon closing the cocks and removing the clearing screw D in front of the bottom arm, and a similar screw in that of the top arm, the valves will roll out of the gage.

A DOUBLE-CYLINDER HOISTING ENGINE.

The cut given herewith illustrates a type of double-cylinder hoisting engine with boiler on the same bed plate. This engine has three patent friction drums; the upper one is used for derrick work or for hoisting the load, and has a pawl and ratchet for sustaining the load at any point and a foot brake for lowering. The cat-head is keyed fast to the drum shaft and revolves as long as the engine is running, but the drum revolves only when the friction lever is applied.

The two smaller drums in front are used for swinging the derrick, etc., and the friction levers attached to them are operated by two foot levers, leaving the hands of the engineer free to operate the large hoisting drum or the throttle valve. In unloading sand or coal boats the cat-head as here operated is very useful in handling the boats.



DOUBLE CYLINDER HOISTING ENGINE: THOMAS CARLIN'S SONS, MANUFACTURERS.

The boiler is of a safety flue type, patented by the makers; the firebox is well stay-bolted, with ring in bottom and giving large water spaces. The usual engine dimensions are 6-in. cylinders with 8-in. stroke and 7-in. cylinders with 10 or 12-in. stroke. The makers are Thomas Carlin's Sons, Allegheny, Pa., and this engine is now being placed upon the market.

THE COST OF DREDGING IN QUEENSLAND.

The Engineer for Harbors and Rivers of Queensland gives some figures regarding the cost of dredging in various harbors which are thus abstracted in "Engineering:"

In 12 years the dredge "Groper" has raised over 4,000,000 cu. yds., at a mean cost of 15.94 cts. per cu. yd. It varied from 32.64 cts. in 1889 to 9.30 cts. in 1886. The three past years have shown 32.64, 21.20 and 20.70 cts., and these are the highest figures The new dredge "Hydra" has been working at a less cost, 16.56 cts. in 1888 and 15.14 cts. in 1891. The "Octopus" varies from 9.32 cts. in 1882 to 19.12 cts. in 1887, which is the last date for which figures are given. The mean of the three dredgers is 15.02 cts., the total spoil being nearly 6¼ million cu. yds. Of course the cost varies very much according to the material, the port and the distance which the spoil has to be carried Last year, for instance, it was only 6.98 cts. per cu. yd. at Cairns and 92.74 cts. in Townsville, the work there consisting of excavating the basin under the outer end of the eastern breakwater, where the presence of occasional soft sandstone bars rendered progress slow and laborious. In the Narrows, at Gladstone, the cost was 55.66 cts. per cu. yd., the material being of an extremely hard and obstinate nature, so much so that the work had to be suspended. Mr. A. William Jardine, the Engineer-in-Chief for Harbors and Rivers, again urges the desirability of introducing the suction type of dredgers and of artificially training the most important rivers.

PETROLEUM ON RUSSIAN LOCOMOTIVES.

Mr. Thomas Urquhart, locomotive superintendent of the Grazi-Tsaritzin line, recently gave an account of the results of several years' researches in the use of petroleum on locomotives. He maintains that 24 grammes (.052 lbs.) of petroleum residuum consumed in compound freight locomotives suffice for a ton mile at the speed of 25 kilom. (15 miles) per hour. The compound locomotive had 8 coupled wheels. The total weight of the train was: locomotive in motion, 48 tons; tender filled, 29 tons; dead weight of cars, 268 tons; load of cars, 410 tons; total, 755 tons; consumption of fuel without lighting, 1.92 kilogs. (4.233 lbs); consumption per train mile, 165 kilogs. (363 lbs.); consumption per ton per train mile, 317 grammes (.634 lbs.).

With a compound locomotive for passenger trains the consumption per ton mile of total train was slightly less, as shown by the following details: Total weight of train, engine and tender included, 268.4 tons; total journey, train miles, 2,226.6; consumption of fuel and lighting, 17.242 kilogs.; consumption per train mile, 7.75 kilogs.; consumption per ton mile, 28.8 grammes. In this case the average speed was 25 miles or 40 kilom. per hour. In brief, one ton (1,015 kilogs.) of petroleum residua develops a power sufficient to travel 1°, a distance of 61.5 miles (98 kilom.), for a train of 755 tons (1,015 kilogs.), at a speed of 16 miles (26 kilom.); 2°, a distance of 133 miles (180 kilom.), for a train of 268.4 tons (of 1,015 kilogs.), at a speed of 25 miles 40 kilom.).

Mr. Urquhart does not give the composition of these residua of petroleum or astatki, but it cannot be very different from that indicated by M. Thwaite according to an analysis of five samples as follows: Carbon, 84.9%; hydrogen, 13.9%; oxygen, 1.2%. With an equal weight the calorific power of this astatki is to that of coal in the proportion of 10 to 7, and it will give in heating an effective yield of 85%.—"Railway News."

The Chicago Elevated Terminal Co., of which Gen. Joseph T. Torrence is president, and of which we gave some details in our issue of Dec. 19, 1891, is we learn by inquiry an entirely independent corporation, extending the offer of terminal facilities to all companies now entering Chicago, but wholly free from any entangling alliances. The company has purchased the right of way of the Atchison, Topeka & Santa Fé Ry., and expects to make a 99-year contract with that road. The company's purpose so far as formed, is to erect an elevated structure about 16 ft. above the surface with sufficient tracks to accommodate at least ten of the trunk lines entering the city, and with way stations every half mile for local traffic. Both way and terminal stations will be equipped with elevators. At the terminal station offices for the use of the several companied will be provided. It is claimed that some 400 lives and twice as many limbs or bad injuries will be saved yearly; while it is also claimed that something like half the present cost of handling city freight will be saved by the introduction of hydraulic and other improved plant. The proposed terminus is on State St., from 12th to 16th Sts. The lower story of the terminal freight station, and all other freight stations, will be equipped for cold storage. These stations it is proposed to make 8 stories high, and to fit them with hydraulic elevators of 100 tons capacity to transfer cars from floor to floor. Each road will have a separate freight house and yards, and yards will be established outside the city for the transfer of through freight. The cost of the Atchison right of way was between $7,000,000 and $8,000,000, which, it is said, is to be paid in cash. The main trunk will divide into lines leading to the south, southeast and southwest at some point toward the outskirts of the city. The plans for the structure are not yet complete, but will provide for first class work in all respects, including 100-lb. rails, tie plates, block signals and interlocking, etc.

The last wooden war-ship in the English navy has been ordered to be sold. This vessel is the "Sapphire," 1,970 tons displacement, built in 1875 at a first cost of $385,000.

The Niagara Falls tunnel progresses rapidly. The last record received shows as follows:

Shafts, etc.	Work done to Dec. 12. ft.	Work done Dec. 12 to 19. ft.	Total driven Dec. 19. ft.
Portal, open cut	170	....	170
" tunnel	1,470	94	1,564
No. 1 West	746	52	798
" East	799	63	862
No. 2 West	1,084	44	1,128
" East	1,086	65	1,151
Total	5,355	318	5,673

Between shaft No. 1 and the portal 118 ft. remains to be driven; between shafts Nos. 1 and 2, 560 ft., and between shaft No. 2 and the canal, 349 ft.

The Justin dynamite shell, which on several occasions has resulted in the bursting of guns or other unfortunate results, has been showing very much more favorably in many recent tests. The trouble with the old shells is said to be that they were weak at the base. The new shells are 3 ft. long and 9 ins. diameter, holding 30 lbs. of dynamite instead of 17 lbs. On Tuesday last, in the glen at Perryville, N. Y., where the former tests were made, one of these shells, loaded with 30 lbs. of dynamite, but without the percussion exploder, and driven by 30 lbs. of prismatic slow-burning powder, was fired into an earth butt placed 75 ft. from the gun. The shell burrowed 17 ft. into the butt without receiving sufficient concussion to detonate the explosive matter. After this test, a shell 22 ins long, containing 8½ lbs. of nitro-gelatine, with the detonating mechanism detached, was fired into a mass of solid rock at a distance of 700 ft. without explosion. Nearly a hundred successful tests of this nature are said to have been made recently.

The Newark-Passaic pollution injunction has been refused by the Chancellor of New Jersey. This suit was commenced in Sept., 1896, by the Newark aqueduct board to restrain the city of Passaic from emptying sewage into the Passaic River. The cause of the refusal was that Passaic had not sufficent time to frame an answer, as no notice was served on the defendants until Oct., 1891, when notice was given that the proofs were closed.

The Niagara Falls hydraulic tunnel is progressing rapidly. From the river to shaft No. 1, a distance of 2,240 ft., with 170 ft. of open cut, the heading is nearly through. Between shafts 1 and 2 less than 600 ft. remains to be driven, 850 + 1,150 ft. having been already driven. Above shaft 2, toward the river above the Falls, 1,140 ft. has been driven. In all, the tunnel is 6,700 ft. long, of which over 5,000 ft. of heading has been already driven. The tunnel, as already described, is 25 × 25½ ft. in section, and is to be lined throughout. We shall shortly give a full description of the complete plant as proposed. As yet it is impossible to give this correctly, for important features are not yet finally decided on.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

PITTSBURG, OHIO VALLEY & CINCINNATI.—The grading is all completed on the 15-mile section of this line between Bellaire and Powhatan, O., 15 miles, and 9 miles of track have been laid. It is expected to have the remaining 6 miles fininished by Feb. 1, 1892. On the section between Powhatan and Marietta, O., no grading has been done.

ODESSA & MIDDLETOWN.—Grading is making good progress on this 4¼-mile line between Odessa and Middletown, Del.

TOLEDO, WALHONDING VALLEY & OHIO.—Surveys have been made for an extension between Loudonville and Kimbalton, O., 68 miles from Kimbalton to Powhatan, O., where connection will be made with the Pittsburg, Ohio Valley & Cincinnati R. R. now under construction. The line is now under construction between Coshocton and Loudonville, 46 miles, and it is expected to have this section open for traffic by July 1, 1892.

HOUSATONIC.—It is stated that this company will at once begin work double-tracking the New Haven & Derby R. R., running from New Haven to Ansonia, Conn., 13 miles.

SANDUSKY & COLUMBUS SHORT LINE.—A correspondent writes us as follows:

This company now has three corps of preliminary and locating engineers in the field, and if the weather permits will have the surveys completed and be ready to let contracts in 30 days. Already 13 miles, from Sandusky to Bellevue, O., have been completed. The remainder of the line from Bellevue to Columbus, O., 100 miles, passes through a fine farming country It is the purpose of the company to build a first class road in every respect, with a maximum curve of 3° and a maximum grade of 26 ft. per mile going north and 40 ft. per mile going south.

Projects and Surveys.

ALTOONA SHORT LINE.—Chartered in Pennsylvania to build a line of railway from Everett, Bedford Co., Pa., to Orc Hill Station, Blair Co., with branches to Langdon, Riddleburg and other points, about 40 miles. Among the incorporators are: Samuel P. Langdon, John H. Wheeler and R. S. Reed, of Philadelphia, Pa.

SOUTHERN.—Existing Roads.

MARIETTA & NORTH GEORGIA.—J. B. Glover, the receiver of this road, writes the "Manufacturers' Record" that authority has been obtained to issue $325,000 of certificates to build the proposed bridge across the Tennessee River at Knoxville, and to buy 35 miles of 60-lb. rails with which to relay its main line.

BRISTOL BELT LINE.—It is officially stated that this company is now surveying a line to Blountville, Tenn., about 11 miles long, which it expects to have in operation in the early spring. The company will soon place an order for two passenger locomotives and a number of passenger and freight cars.

OWENSBORO, FALLS OF ROUGH & GREEN RIVER.—Surveys have been completed for an extension of this railway from Fordsville to Coneyville, Ky., a distance of 30 miles, to connect with the Newport News & Mississippi Valley R. R.

WEST VIRGINIA CENTRAL & PITTSBURG.—A press dispatch says:

"Engineers of the West Virginia Central & Pittsburg R. R. are making preliminary surveys for the proposed extension from Cumberland to Baltimore, Md. If the route by way of High Knob be chosen, about 600 ft. of tunnel will be necessary and an additional half mile through the South Mountain. The present tortuous route of the Baltimore & Ohio from Frederick to Baltimore requires nearly 60 miles of rails, while the more direct line over the mountains proposed by the West Virginia Central will reduce the distance fully 15 miles and the time three-quarters of an hour."

ROANOKE & SOUTHERN.—A press dispatch says:

"President S. H. Fries, of the North Carolina Construction Co., says that the entire line of the New Roanoke & Southern R. R., from Roanoke, Va., to Winston, N. C., will be opened for traffic Jan. 15. The completed section of the road from Winston to Madison, N. C., has been operated for more than a year and the business has been satisfactory. The road opens up a new territory that is rich in agricultural, mineral, and manufactured products. A traffic arrangement has been entered into with the Norfolk & Western whereby the Roanoke & Southern will secure a Northern outlet for its business. Future extensions will be made south from Winston, N. C. The Baltimore & Ohio is said to have had under consideration for some time a plan to extend its Virginia Valley branch to Roanoke, there to connect with the new Southern line."

TENNESSEE MIDLAND.—The people along the route of the proposed extension of this road from Parryville, Tenn., east, are holding meetings for the purpose of securing aid for its extension.

OHIO RIVER.—This company will, it is stated, begin work at once on its proposed extension from Guyandotte to Huntington, W. Va., 3.5 miles. The contract has been let to Jas. A. Hughes.

Projects and Surveys.

SHELBYVILLE, NASHVILLE & NORTHERN.—It is stated that surveys have been resumed upon this proposed railway from Shelbyville to Nashville, Tenn., 50 miles. Frank R. Foss, of Nashville, Tenn, is the engineer in charge of the surveys.

MEMPHIS & ATLANTIC.—An official of this company is reported as saying that construction would be resumed on its proposed line by Feb 1. The road is projected to run from Memphis, Tenn., to Tuscaloosa, Ala., 230 miles. F. M. Abbott, of West Point, Miss., is president.

WARSAW & CUMMING.—A correspondent writes us that this road is projected to run from Norcross or Pitman, Ga., to Cumming, Ga., a distance of about 20 miles from Norcross and 18 miles from Pitman. It is expected that the right of way can be easily secured and $15,000 has already been obtained in aid of the road. The contracts for construction will propably be let at an early date. H. T. Abbott, of Warsaw, Ga., is at the head of the enterprise.

SUWANNEE & GULF.—The Suwannee River Phosphate Company has chartered this company to build a railway from a point near the Suwannee River through Suwannee, Alachua and Levy counties to Bronson or Archer. The company has secured right of way for a branch from near Trenton, in Alachua Co., to the Suwannee River, which it intends building. Charles P. Turner, 6 East Alabama St., Atlanta, Ga., is superintendent.

VIRGINIA.—The following companies have applied to the State Legislature for charters: Southwest Virginia Central R. R. Co., to build a railway in Craig.—Baltimore, Roanoke, Montgomery and Pulaski counties.—Richmond & Southwestern R. R. Co.; from Manchester, Va. to Sutherland's, Va.; W. W. Anderson, W. S. Gooch.—Roanoke, Salem & Western R. R. Co.; from Roanoke, Va. to the Kentucky line; Jas. E. Langhorne, D. B. Strouse, Salem, Va.—Newport R. R., Hotel & Land Improvement Co.; from West Point to Chesapeake Bay; Wm. Marshall, John C. Robertson.

OXFORD & COAST LINE.—Surveys have been begun for this proposed railway from Oxford to Wilson, N. C., 60 miles. It is stated that the prospects seem good for beginning construction soon.

SUMTER, LAKE CITY & CONWAY.—This company, which has a bill before the South Carolina Legislature for a charter, proposes to build a railway from Sumter to Conway, S. C. Among the incorporators are: M. H. Fields, Richard Brown, C. A. Ravenel and others.

AUGUSTA, AIKEN & CONWAY.—This company noted in our last issue, will soon complete its organization and let contracts for construction. John G. Evans Aiken, S. C., is interested.

SOUTH CAROLINA.—Henry Schuchte and others, of Columbia, S. C., have applied to the South Carolina Legislature for a charter to build a railway from some point on the Adhepoo River, Calleton Co., to some point on the Elisto River, with the privilege of extending line from the Ashepoo River to the Savannah River.

SUMTER & WATEREE.—Surveys have been completed for this railway from Sumter to Camden, S. C., about 30 miles. Pres., I. D. Blanding, Sumter, S. C.

MIDLOTHIAN, RICHMOND & MANCHESTER.—The Virginia Legislature has extended the time for beginning construction on this line from Manchester to the Midlothian mines.

NORTHWEST.—Projects and Surveys.

LITTLE WABASH.—This company has decided to let the contracts for building its line from Effingham to Carmel, Ill.

CAMBRIDGE, MINNEAPOLIS & DULUTH.—This railway company has been chartered in Minnesota with the following officers: Pres., H. F. Barker; V. P., D. O. Anderson; Sec., C. W. Van Winner, and Treas., O. A. Hallis.

DULUTH, MESABI & NORTHERN.—A press dispatch says

"Donald Grant has agreed to build the Duluth, Mesabi & Northern road, and the memoranda have been filed in the hands of the attorneys for drawing up the contract. The road is to be completed from the mouth of the Artichoke River to the Iron Mountain company's property, a distance of 48 miles, by Aug. 1, and $150,000 is to be spent before spring. During the winter the bridge across the St. Louis River at the Artichoke will be built, and the foundations put in for the bridge across the White Face and the upper St. Louis. All of these bridges will be Howe truss bridges. Nothing will be done for some time about building the spur to the Biwabic and Cincinnati mines."

QUINCY, KOKUK & CHICAGO.—Bids are being received for constructing and equipping this line, 60 miles long. The maximum grade is 1%. F. C. Horn, Exchange Bldg. Chicago, is the Chief Engineer. Plans and specifications can be seen at the engineer's office.

CHICAGO, KEOKUK & SOUTHWESTERN.—Chartered in Illinois to build a line of railway from Havana, Ill., via Keokuk, Ia., to Kansas City, Mo. Among the incorporators are: W. K. Johnson, Kokuk, Ia., H. R. Dickinson, Carthage, Ill.

SOUTHWEST.—Existing Roads.

CHICAGO, ROCK ISLAND & PACIFIC.—A press dispatch from Gainesville, Tex., says:

"Couriers just in from the scene of operations at the south end of the road report three corps of surveyors at work on the line between Minco, in the Chickasaw Nation, and Red River. The line followed south from Minco runs near the 98th meridian, crossing the Washita about 400 yards east of that line, passing south by Rush Springs and running eastward. The crossing of the Red River has not been determined yet, but the road seems headed for Gainesville. The line from Minco to the Washita is being cross-sectioned now, and work is expected to commence soon, graders being on hand now at Minco."

CHOCTAW COAL & RAILWAY CO.—Dispatches from El Reno, Ind. Ter., state that tracklaying has been resumed on the line from Ft. Reno east to Oklahoma City, all but twelve miles of which has been completed.

KANSAS CITY, FT. SMITH & SOUTHERN.—It is stated that surveys will soon begin for an extension of this railway south from Sulphur Springs, Ark., to Ft. Smith, Ark., and that steps will be taken at once to begin work.

HOUSTON & TEXAS CENTRAL.—The right of way has been all secured for the extension of this road to Llano, Tex., and it is stated that work will be begun in the early spring.

Projects and Surveys.

KANSAS CITY, SOUTHWEST CITY & SOUTHERN.—Chartered in Missouri to build a line of railway from Joplin, Mo., to Southwest City, Mo., a distance of 40 miles. Among the incorporators are: J. C. Seabourn, G. W. Smith and W. D. Palson.

KANSAS CITY & NEW ORLEANS.—This company proposes to build a railway from the Red River across Bowie and Cass counties, Tex., to the head of navigation on the same stream about 75 miles above Shreveport, La. Sec., H. B. McCulloch, 314 Commerce St., Dallas, Tex.

ROCKY MT. AND PACIFIC.—Existing Roads.

SANTE FE, PRESCOTT & PHŒNIX.—The grading on this line from Phœnix, Ariz., north to the Aqua Fria River is well advanced. Two surveys have been run from Prescott, Ariz., south to this point, but no route has been definitely settled upon. From Prescott north to a connection with the Atlantic & Pacific Ry., it is stated the Central Arizona R. R. will be used.

SOUTHERN PACIFIC.—A press dispatch from Phœnix, Ariz., says:

"Engineer Eads, of the Southern Pacific Co., arrived in Phœnix to-day with a large corps of men and teams and will begin the survey of the route through Black Cañon to connect the Maricopa & Phœnix R. R. with the Arizona Central R. R. at Prescott. Eads says that a large force of men will be put on at once, and the work rushed through to completion. Forty carloads of material for this route are expected to arrive by the middle of next week."

Projects and Surveys.

BELLINGHAM BAY & EASTERN.—This company has been chartered in Washington to build the proposed railway from New Whatcom to the Blue Cañon coal mines. S. T. Hauser and J. J. Donovan, of Fairhaven, Wash., are interested.

FOREIGN.

MEXICO, CUERNAVACA & PACIFIC.—Work has been commenced on this proposed railway from the City of Mexico to the Pacific Coast. It is stated that there is a large grading force and that work will be rapidly pushed.

MEXICAN CENTRAL.—A press dispatch says:

"The Mexican Central Ry. Co., expects to finish its Tulla-Pachuca Branch, which will be about 43 miles long, by Feb. 2, 1892. The concession granted for this branch also allows of a continuance of the line to Tampico. The Mexican Central Co. is now making a preliminary survey with this object in view, but with no immediate intention of construction. In fact, the purpose of the survey at present is to study the country, and the cheapest methods for obtaining the best results."

PENINSULAR.—According to the present estimates of Engineer Earle, the survey of the entire line of this railway from San Diego, Cal., to San Quintin, Lower Cal., will be completed in 2½ months, or about March 1. Two forces are at work in the field, one working from San Diego south, and the other from San Quintin north. The former force is at Burro Cañon, 55 miles south of San Diego. The latter force is in Trinidad Valley. There is between them a gap of about 110 miles, and they are closing that gap as rapidly as possible. Some portions of this gap have already been surveyed in a preliminary way, but there are other portions over which no lines have been run, and where the work will be slow. Seventeen miles of roadbed have been constructed from San Quintin north, and the remainder of the 45 miles required to carry the line to Colnet will be finished as soon as possible. It is not now believed, however, that the contract will be let for the construction of the entire line until the survey of the whole route has been completed.

MICHOACAN.—Surveys for the location of this road have begun, starting from mile post 249, on the Morelia Branch of the Mexican National Ry. This is the concession granted a year ago to Messrs. Sydney Marshall and H. E. Dennie, who were authorized to build a road to connent the Districts of Pátzcuaro, Acámbaro, Ario, Uruapam, etc. in the State of Michoacán, with some point on the National. It is believed that 28 miles will be built this coming year, thus opening up one of the best timber regions in the state.

ELECTRIC RAILWAYS.

BROOKLYN, N. Y.—The Atlantic Avenue R. R. Co. and the Brooklyn City R. R. Co. are making extensive preparations for introducing the electric system of traction, using overhead wires.

CANISTEO, N. Y.—The Canisteo Valley Electric Ry. Co. has been incorporated by W. T. Bailey, George L. Dairs and W. A. Stephens; $50,000.

MOUNT VERNON, N. Y.—An electric railway is to be built to connect with the Yonkers street railway, and is to be completed by next April. The Yonkers line is to be converted to an electric system.

CHICAGO, ILL.—An electric road on 75th St., from Auburn Park to Windsor Park, will be built by the Chicago City Ry. Co. if the property owners will raise $10,000 a mile, or $40,000 in all, for a single track line. Steps are being taken to raise this amount.

PUEBLO, COLO.—An electric railway to Overton, a distance of 6 miles, is to be built by B. F. McDaniels and others, a franchise having been granted by the County Commissioners.

HELENA, MONT.—The Union Ry., which has been using animal power, and the Helena, Hot Springs & Smelter Ry., using steam dummy engines, have been consolidated and are to be operated by a new company. The entire system will be about 16 miles long and is being equipped for electric traction. It is expected to have the powerhouse completed and the cars in operation by February. The consolidation and financial arrangements were effected by R. S. Vivian, of Kansas City, Mo.

ELEVATED RAILWAYS.

CHICAGO, ILL.—The Chicago & South Park Elevated Ry. Co. has been incorporated to build a cross town line. Pres., A. J. Cooper; Sec., J. B. Malette. Capital stock, $1,000,000.

HIGHWAYS.

NEW JERSEY.—At the town meeting at Moorestown next spring a strong effort will be made to secure a larger appropriation than usual for the building of improved roads in Burlington Co., as the experimental roads laid with Telford this year have given satisfaction. Many of the largest tax-payers are said to favor bonding the township for $100,000 if necessary for this purpose, claiming that the interest on these bonds at 5% would cost taxpayers about the same as the present work done every year on the dirt roads, only to be done over again the next year. The township now expends about $6,000 per annum on road repairs.

BRIDGES, TUNNELS AND CANALS.

HARRISBURG, PA.—The City Engineer has completed the plans for the proposed iron bridge over the Philadelphia & Reading Railroad track at Cameron St. It will be a plate girder structure 100 ft. long.

ELKTON, MD.—The Philadelphia, Wilmington & Baltimore R. R. Co. will build a bridge across Elk Creek.

WATER-WORKS.

NEW ENGLAND.

CHERRYFIELD, ME.—A village charter has just been accepted which authorizes the building of works. Chas. A. Stewart is Village Clerk.

DOVER AND FOXCROFT, ME.—It is reported that the Dover & Foxcroft Water Co. talks of changing its source of supply from the Piscataquis River to Garland Pond.

BERLIN, N. H.—G. D. Stratton and J. F. Libby, of Gorham, have formed a water company, it is reported, and will begin to build works next spring. The supply will be from a spring.

NEWTON, MASS.—The sum of $16,000 has been appropriated for the purchase of new mains during the next year.

PROVINCETOWN, MASS.—Works are projected. The "Advocate" strongly urges that the town build and own the works.

STONEHAM AND WAKEFIELD, MASS.—Stoneham is considering the purchase of the private works, and has appointed a committee to confer with Wakefield on cooperating in the plan.

MIDDLE.

ARKVILLE, N. Y.—The Arkville Water Co. was incorporated Dec. 26 by W. F. Cowan, F. B. Gilbert and others. Stamford; capital stock, $10,000.

LOCKPORT, N. Y.—The Lockport Water Supply Co. wishes the city to obtain authority and buy from it water for the city, the water to be brought through a canal from Niagara River.

SYRACUSE, N. Y.—Bids for $500,000 of bonds for the new city supply from Skaneateles Lake will soon be sold, the Water Board, according to the "Herald," having resolved to advertise for bids, and proceed with construction.

BALTIMORE, MD.—The Roland Park Co., Blackstone Building, informs us that it wishes to buy a steel tank 20 ft. in diameter by 40 ft. high, to be placed on iron supports 30 ft. high. The tank will be used in connection with the works to supply Roland Park.

BRUNSWICK, MD.—The Baltimore Land & Improvement Co. proposes to supply East Brunswick. A pump and tank are talked of.

SOUTHERN.

BERRYVILLE, VA.—The works are well under construction by the Berryville W.-Wks. Co., and bonds are being sold. Prest., G. C. Thomas; Engr. and Contr., J. P. Herdic, Williamsport, Pa.

ALBANY, GA.—The Council has invited Engr. J. C. Chase, Wilmington, N. C., to visit the city in connection with the proposed new water and sewerage system.

OXFORD, ALA.—Negotiations for works are nearly completed with a Philadelphia company.

WARRIOR, ALA.—A contract for works has been made with Fred. Balcon and H. E. Mondeville.

HOPKINSVILLE, KY.—J. A. Jones, representing the Michigan Pipe Co., Bay City, has been talking of putting in a combined water and sewerage system.

LUDLOW, KY.—The Council will receive bids until Feb. 18 for furnishing the city with about 200,000 galls. of water daily. Address A. V. C. Grant, Cy. Clk.

NORTH CENTRAL.

CYGNET, O.—The people have voted to issue bonds for works.

SALINEVILLE, O.—Works are talked of.

WESTON, O.—Councilman Mullaly has been appointed to investigate the cost of works.

WASHINGTON, IND.—The pumping station was burned Dec. 27, and part of the machinery was badly injured, leaving the city, according to press dispatches, without water. The works are controlled by Moffett, Hodgkins & Clarke, Syracuse, N. Y.

NORTHWESTERN.

BURLINGTON, IA.—The "Hawkeye" advocates the purchase of the company's works by the city. Nothing has been done in this direction.

MINNEAPOLIS, MINN.—The City Engineer has been instructed to advertise for bids for next year's water pipe.

PARSONS, KAN.—A new contract is being proposed which if accepted by both the city and company will call for mechanical filters, a stand-pipe, at least three miles of mains and 40 hydrants, and also for a new pumping station.

GRAND FORKS, S. DAK.—Bids will be received until Jan. 4 for furnishing and laying 1½ miles of 6 to 10-in. cast-iron pipe, work to be completed by July 1, 1892. Address Cy. Engr. W. S. Russell.

RAWLINS, WYO.—A. Igo, Greeley, Colo., has received the contract for building works here. A company will own the works and is offering bonds for sale.

POCATELLO, IA.—New works are proposed by J. J. Cusick, F. D. Toms and others. It is proposed to bring water from Mink Creek, about seven miles from town, to a 2,000,000-gallon reservoir. Estimated cost, $100,000. A franchise has not yet been secured. The Union Pacific Ry. Co. and the Centre St. Water Co. now supply water.

SOUTHWESTERN.

ABILENE, TEX.—It is reported that the town has sold its works to private parties, who will expend $100,000 in improvements. Five miles of pipe will be laid, some or all of which has been ordered. The Abilene W.-Wks. Co. has been incorporated by Geo. P. Phillips, R. E. and Jas. M. Carter, of Marshall, and J. P. Miller, Chicago, Ill.; capital stock, $100,000.

HONEY GROVE, TEX.—Address H. M. Gibson, Mgr., regarding proposed works.

WACO, TEX.—The Waco Water & Light Co. has offered to sell or lease its works to the city.

PACIFIC.

EVERETT, WASH.—A company with a capital stock of $50,000 has been incorporated to supply this new town.

MEDICAL LAKE, WASH.—Plans and specifications for works have been ordered and a vote on the subject will soon be taken.

SNOHOMISH, WASH.—Bids for building works will be received by Cy. Clk. T. E. Marks until Jan. 9, 1892. Proposals were asked in our advertising columns last week. M. Stixrud, Seattle, is the engineer in charge.

SANTA BARBARA, CAL.—The Mountain Water Co. has let the contract for developing from 5 to 100 miner's inches of water to L. A. Crandall, Los Angeles. The price is $1,000 per inch for all water developed up to 20 ins., then $500 per inch for all from 21 to 100 ins., inclusive. The company has received about $50,000 of subscriptions to its stock, and it is said will sell water to the city, evidently to supply proposed city works. The supply is now furnished by a company.

CANADA.

MONTREAL, P. Q.—Bids are wanted until Jan. 5, for 550 tons of cast iron pipe. Address B. D. McConnel, Supt. W.-Wks.

ARTESIAN WELLS.

RIVER FOREST, ILL.—An artesian well will be sunk. G. C. Morgan, Chicago, Engr.

SEWERS.

TOGUS, ME.—The survey is completed for a sewer 6 miles long from the Soldiers' Home to the Kennebec River.

BOSTON, MASS.—The award of the contract for section 22 of the metropolitan sewerage system, advertised to have taken place Dec. 23, has been postponed. For particulars address H. F. Bridgman, Asst. Engr.

BUFFALO, N. Y.—The City Engineer has been directed to readvertise for bids for the construction of a tile sewer in Walden Ave. It is to be 4,000 ft. long, 12 to 20 ins. in diameter, and will cost about $3,000.

HOLLEY, N. Y.—The Sewer Board has authorized the clerk to employ an engineer to prepare plans and specifications for the proposed sewers.

WEST BERGEN, N. J.—The new sewer will cost $20,000, which the taxpayers must pledge themselves to pay before work will be commenced.

DUNMORE, PA.—The Council will expend $10,000 on a sewer to be built this year.

KITTANNING, PA.—Civil Engineer R. H. Wilson, of Saltsburg, Pa., at the request of the City Council has prepared plans and specifications for a complete sewerage system to cost complete $32,000.

PHILADELPHIA, PA.—An appropriation of $50,000 has been made for extension of main sewers in Ward 22.

ATHENS, GA.—The $25,000 of sewer bonds is nearly used up, and it is claimed to be absolutely necessary that the system be continued on several other streets.

DENISON, TEX.—Bonds for $25,000 for sewerage construction will soon be issued.

WACO, TEX.—About 2,500 ft. of 6-in. sewers will be constructed soon.

ST. JOSEPH, MO.—Contracts have been let to W. E. Gibeon for sewers in 4 districts, to Owen Danaher for a sewer in one district, and to Andrew Sheridan.

ST. LOUIS, MO.—Bids were opened Dec. 22 on 6 contracts for sewer constructions, the lowest bids aggregating $20,243.

SPRINGFIELD, O.—The City Engineer estimates the cost of a 24-in. sewer on North Limestone St., 2,793 ft. in length, at $8,626; and others, aggregating 1,728 ft., at a total of $5,973.

EMPORIA, KAN.—The plan of sewerage submitted by Cy. Engr. Strout has been adopted by the Council.

PUEBLO, COL.—A sewerage system has been ordered surveyed in the southwestern part of the city.

MODESTO, CAL.—A complete system is being urged. It is estimated that a main sewer can be built from the Ross House to the river for $30,000.

SAN LUIS OBISPO, CAL.—The City Engineer has been instructed to prepare plans and specifications for several additional sewers.

SEATTLE, WASH.—City Engineer Gardner has reported his estimate for material for lining the Lake Union sewer tunnel, as follows: If brick is used, there will be needed 1,500,000 brick and 2,500 bbls. of Portland cement; if concrete is used, 3,000 cu. yds. crushed rock and 3,000 bbls. of Portland cement. It was decided to ask bids for both kinds of material.

STREETS.

BOSTON, MASS.—Mr. Carter, Supt. of Sts., has reported that to pave Bennington St. with granite blocks will cost $30,000. Dorchester Ave. is to be paved at an estimated cost of $125,000.

SOMERVILLE, MASS.—The Committee on Highways reported Dec. 24 regarding the report of the City Engineer as to the construction of the proposed parkway in Broadway. It was found that the cost would not exceed $5,000, and that the parkway should be constructed as soon as possible.

GREENBUSH, N. Y.—The trustees have voted to issue $39,000 of bonds for the grading, forming and flagging of Third and Partition Sts.

COATESVILLE, PA.—The Council will borrow $20,000 from one of the borough banks for street improvements.

DENISON, TEX.—Bonds for $25,000 for street improvements will soon be issued.

LOCKHART, TEX.—The City Council asks bids for macadamizing streets.

KNOXVILLE, TENN.—The citizens of West Knoxville voted Dec. 19 on the proposition to issue $75,000 for public improvements.

ST. LOUIS, MO.—The Board of Public Improvements desires bids till Jan. 12 for stone flagging, 2 contracts; telford pavement, 1; pine wood blocks, 1; grading, curbing, guttering, constructing telford pavement and cross-walks, 3 contracts.

ROCK ISLAND, ILL.—The lowest bid for paving Third Ave., Nineteenth St., and Commercial Alley was from the Rockford Construction Co., as follows: Rock Island brick, $66,256; Galesburg top and Rock Island bottom, $71,690.

SUPERIOR, WIS.—Bonds for improving Lamborn Ave., to the amount of $42,000, have been sold.

OAKLAND, CAL.—The City Council on Dec. 21 passed the ordinance for $800,000 bonds for the West Oakland Park and Lake Boulevard. The election will be April 21

ELECTRICAL.

ANNAPOLIS, MD.—The legislature will be asked to authorize the city to issue $90,000 of bonds for the construction of an electric light plant and other improvements.

MONROE, N. C.—The American Construction Co. has been granted a franchise to erect an electric light plant.

LUDINGTON, TENN.—The city has voted to issue bonds for $5,000 for electric light.

WICHITA, TEX.—A company has been organized and a plant will soon be established.

ELROY, WIS.—The city council is considering a proposition from an electric light company with a view to the establishing of a plant.

BROCK, NEB.—The city has decided in favor of electric light and a plant will soon be in operation.

NEW COMPANIES.—Crowdus Electric Co., Chicago; W. S. Baker, W. Crowdus and C. H. Cooley; $2,000,000. ——Ballard Electric Co., Washington, D. C.; D. H. McMullen, G. M. Armour and Thos. Winsor; $25,000.——Card Electric Motor & Dynamo Co., Cincinnati; J. W. Wilshire, Geo. Bullock and O. W. Jantz; $100,000.

CONTRACT PRICES.

PAVING.—Massillon, O.—For furnishing brick, grading, graveling, tarring and laying the brick on East Main St., there were 15 bids. The lowest was as follows: Borren & Rosser, of Steubenville; Massillon brick, $1.14 per sq. yd.; Malvern brick, $1.16.

STONE.—San Francisco, Cal.—Charles S. Harney has been awarded the contract for supplying basalt blocks, crosswalks and gravel for use on the public streets during the ensuing year. Blocks are to be supplied at $34.95 per m., crosswalks at 64 cts. per lin. ft. and gravel at 73 cts. per ton.

MISCELLANEOUS.

DITCH.—A ditch is to be built near Riverton, on the line of the C., B. & Q. R. R. Bids, with price per cu. yd., will be received by H. R. Fardwell, County Surveyor, St. Joseph, Mo., till Jan. 6.

JAIL.—Proposals will be received till Jan. 23 for plans, specifications and construction of a brick jail with steel cells, capacity not less than 100 prisoners, to be built on the present jail site, which is 36 ft. × 80 ft. Address Geo. L. Bennett, Clerk of City Council, Roanoke, Va.

WHARF EXTENSION.—Tenders will be received till Jan. 11 for all the work in connection with the proposed extension of South Rodney wharf, including dredging and building of wharf and warehouses. For copies of specifications, apply to A. Chipman Smith, Director, Dept. Pub. Wks., St. John, N. B.

MANUFACTURING AND TECHNICAL.

LOCOMOTIVES.—The Schenectady Locomotive Works, of Schenectady, N. Y., have orders for 25 engines for the West Shore, and 20 ten wheel freight engines for the Chicago, St. Paul, Minneapolis & Omaha. The Pittsburg Locomotive Works, of Pittsburg, Pa., built 115 engines during 1891, The Baldwin Locomotive Works, of Philadelphia, Pa., have built a rack rail engine for Brazil. The Baltimore & Ohio will add 45 engines to its equipment. The Michigan Central has built a ten-wheel engine at St. Thomas, Ont.; cylinders, 19" × 24 ins.; driving wheels, 68 ins. diam.; weight, 94,000 lbs.

CARS.—The Haskell & Barker Car Co., of Michigan City, Ind., has an order for 300 box cars for the Lake Erie & Western. The Terre Haute Car Co., of Terre Haute, Ind., is building 500 stock cars for the Cleveland, Cincinnati, Chicago & St. Louis. The Peninsular Car Works, of Detroit, Mich., has an order for 500 box cars for theve Chicago, St. Paul, Minneapolis & Omaha. The Harris Car Co., of Portland, Me., has been incorporated to build passenger cars under the patents of L. J. Harris, who is president of the company; treasurer, E. M. Wheaton, of Putnam, Conn. The Toledo Rolling Stock Co., of Toledo, O. has been incorporated by Sheldon C. Reynolds, A. W Cotter and Emory D. Potter; $1,000,000.

CAR COUPLERS.—The Hinson Car Coupler Co., of Chicago, has been awarded contracts for equipping 1,400 cars for the East Tennessee, Virginia & Georgia and East Tennessee railways, and has also contracts for 500 of its new type coupler.

STATIONS.—The contract for a new stone passenger station for the New York Central at Garrison-on-Hudson, N. Y., has been awarded to W. S. Laden, of Cold Spring. It will be similar in style to the one recently built at Tarrytown, and is to be completed by July. The plans were prepared by Mr. Fouquet, architect of the road. The contract for the ironwork for the Union station at St. Louis has been awarded to the Pittsburg Bridge Co., of Pittsburg, Pa., at $350,000.

THOMAS CARLIN'S SONS, of Allegheny, Pa., report an order from the Blairsville Tin Plate Co. for four large tubular boilers, and one from the Chambers & McKee Glass Co. for another 50 HP. boiler, being a duplicate of a former order. Both orders were filled in the next working day after their receipt.

FILTERS.—The water works company of Little Rock, Ark., has placed a second order with the National Water Purifying Co. to increase its filter plant.

THE KEYSTONE BRIDGE CO., of Pittsburg, Pa. is building 3 plate girder spans of 100 ft. on the Pittsburg & Lake Erie, 3 double track spans on the Belt Ry. of Chicago and 20 spans on the Pennsylvania between Coshocton and Loudonville, O.

FRANK J. McCAIN & BROS., of Chicago, have been awarded contracts for erecting the following work: dome of Horticultural building; Machinery and Fisheries buildings, and the heavy trusses in the Forestry building for the World's Columbian Exposition; Ogden Ave. viaduct, Chicago; a double track span over the canal for the Northern Pacific; 20 spans on the Pennsylvania between Coshocton and Loudonville; 3 double track plate girder spans of 100 ft. on the Pittsburg & Lake Erie, and 3 double track spans on the Belt Line, Chicago. They will also erect the Lake Shore & Michigan Southern warehouse, 8 stories high, requiring 800 tons of steel.

NEW COMPANIES—Edgar Pressed Brick Co. of Wausau, Wis.; works at Edgar, Wis.; W. Alexander, Dr. A. W. Trevitt and Hiram Dunfield; $10,000. Traffic Construction Co., of Chicago, Ill.; N. W. Gifford, W. S. Shaw and J. F. Stephens; $500,000. International Steel Post Co., of Chicago, Ill.; H. S. Gillette, W. H. Taylor and DeWitt Stearns; $500,000. Chicago Roller & Railway Rapid Transit Co., of Chicago, Ill.; D. R. Goudie, J. O. Williams, F. A. Battey; $500,000. Ironton Structural Steel Co., of Duluth, Minn.; R. T. McCabe and W. P. Heath, of New York, and R. C. Bellville, of Trenton, N. J.; $1,000,000. Thayer Water Gas Furnace Co., of Pittsburg, Pa.; W. C. Thayer, R. D. King and E. B. Saull; $5,000.

CURRENT PRICE LIST.

RAILS.—New York: $30 to $30.50; old rails, $21 to $21.25 for iron and $14 to $15 for steel; girder rails, $40. Pittsburg: $30; old rails, $22.75 for iron and $17 to $18 for steel. Chicago: $31; oldrails, $21.50 to $21.75 for iron and $14 to $14.50 for steel.

TRACK MATERIALS.—New York: steel angle bars, 1.7 to 1.9 cts.; spikes, 2.15 to 2.25 cts.; track bolts, 2.8 to 3 cts., with square and hexagon nuts. Pittsburg: splice bars, 1.7 to 1.8 cts. for iron or steel; iron or steel spikes, 2.15 cts.; iron track bolts, 2.65 cts. with square and 2.75 cts. with hexagon nuts. Chicago: splice bars, 1.8 cts. for iron and steel; spikes, 2.2 to 2.25 cts.; track bolts, 2.7 to 2.75 cts. with hexagon nuts.

PIPE.—Cast iron, $20 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 47½% on black and galvanized butt-welded; 67½ and 55% on black and galvanized lap-welded. Casing, 55%.

FOUNDRY PIG IRON.—New York: $14.50 to $18. Pittsburg: $14 to $16. Chicago: $14.25 to $16.

LEAD.—New York: 4.25 to 4.35 cts. Chicago: 4 to 4.05 cts. St. Louis: 3.9 to 4 cts.

STRUCTURAL MATERIAL.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.9 to 2.1 cts.; tees, 2.4 to 2.75 cts.; sheared iron plates, 1.85 to 2.25 cts.; steel plates, 1.9 to 2.1 cts. for tank, 2.15 to 2.3 cts. for shell, 2.4 to 2.65 cts. for flange, 3 to 3.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles 1.9 to 2 cts.; tees, 2.4 to 2.5 cts.; universal iron mill plates, 1.95 to 2 cts.; sheared steel bridge plates, 2 to 2.1 cts.; refined bars, 1.75 to 1.85 cts.; steel plates, 1.85 to 2.5 cts. for tank, 2. to 2.3 cts. for shell, 2.25 to 2.4 cts. for flange, 3.5 to 4.25 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.05 to 2.15 cts.; tees, 2.4 cts.; universal plates, 2.12½ cts.; sheared steel plates, 2.2 to 2.25 cts.; steel plates, 2.2 cts. for tank, 2.6 to 3.5 cts. for shell, 3.6 cts. for flange.